Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.
+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.
+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.
+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google books

https://books.google.com

WIDENER LIBRARY
HX H6T3 J

Harvard University

LIBRARY OF THE

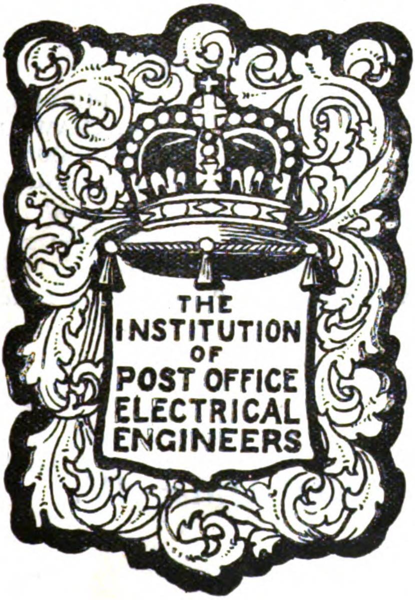
SCHOOL OF ENGINEERING

MAY 2 191

TRANSFERRED
TO
HARVARD COLLEGE
LIBRARY

Engi.

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOLUME
IV

APRIL 1911
TO
MARCH 1912

Jul. 1, 1919
Transferred to
Harvard College Library

The Post Office Electrical Engineers' Journal.

THE ORGAN OF THE INSTITUTION
OF POST OFFICE ELECTRICAL ENGINEERS.

A QUARTERLY JOURNAL DEVOTED TO:

Telephones, Telegraphs (Aerial, Underground, Submarine and Wireless) and all matters of Interest to Communication Engineers all over the World.

EDITED BY:

H. R. KEMPE, M.Inst.C.E., M.I.E.E.
H. HARTNELL, A.M.I.E.E.
A. W. MARTIN, A.M.I.E.E.
J. E. TAYLOR, A.M.I.E.E.
T. F. PURVES, A.M.I.E.E.
J. M. CRAWFORD.
A. O. GIBBON.
E. T. LARNER.
D. H. KENNEDY, A.M.I.E.E.
(**Managing Editor.**)
(*Office of the Engineer-in-Chief, G.P.O., London, E.C.*)

VOLUME IV.

No. 1—April, 1911	Pages	1—96
No. 2—July, 1911	,,	97—208
No. 3—October, 1911	,,	209—288
No. 4—January, 1912	,,	289—376

SUBJECT INDEX.

Original Articles, written specially for the Journal, are given in thick type; and Translations, Abstracts, Reviews, etc., in thin type.

PAGE

Advertising the Telephone—John Lee . . . 111
America, Notes from . . . 287
Ampère—Andrew Fraser . . . 41
Anglo-Belgian Loaded Telephone Cable, New . . . 70
Anglo-Belgian Telegraph Commission, 1911 . . . 347
Arbitration . . . 281
Automatic Counter for Subscribers' Effective Calls—P. V. Christensen . . . 338
"Automatic" Situation . . . 349
Automatic Telephone Exchange Systems . . . 194

Benevolent Society—Metropolitan Central . . . 82
Biographies—Andrew Fraser
  Ampère . . . 41
  Ohm and his Law . . . 131
  Faraday . . . 270
Books, New . . . 285, 371
Books, New, in our Library . . . 286
Books Received . . . 83, 202
British East Africa, The Telephone in . . . 117
British Science Guild . . . 192
Brown, W. . . . 372

Cable Faults and their Removal: An Experiment . . . 345
Cables, Lead-covered Aërial, Practical Hints on the Erection of—E. Ogden . . . 156
Cable, New Anglo-Belgian Loaded Telephone . . . 70
Cable Problems . . . 251
Calls, Automatic Counter for Subscribers' Effective—P. V. Christensen . . . 338
Canadian Pacific Railway, Telegraph Construction on—E. A. Lakey . . . 152
Carr, Mr. G. M. . . . 90
Chess . . . 201
Chess Club, Engineering Department . . . 366
Conference of Post-Office Engineers . . . 65

PAGE

Construction, Telegraph, on the Canadian Pacific Railway—E. A. Lakey 152
CORRESPONDENCE:
  The Post Office and Engineering—"A Correspondent" 45
  Commercial Efficiency—E. H. Walters 204
  International Conference of Telegraph and Telephone Traffic Engineers—Geo. W. J. Praat 367
  Enamelled Copper Wire—"Interested" 367
  „ „ W. B. Smith 368

Decay and Preservation of Timber—W. H. Matthews, B.Sc. 162, 243, 300
Desiccators—J. G. Hines 262
Dielectrics, The Use of, and the Principal Tests applied to them—Thomas Germann and Stanley W. Hills 30
DINNER, POST OFFICE ENGINEERING DEPARTMENT 49, 65
Diversion of Underground Plant—J. E. Gibbons 289

Enamelled Wire—W. B. Smith, A.I.E.E. 259
ENGINEERING DEPARTMENT CHESS CLUB 366
ENGINEERING DEPARTMENT, POST OFFICE, EIGHTH ANNUAL DINNER 49, 65
ENGINEERS, CONFERENCE OF POST OFFICE 65
ENGINEERS, ELECTRICAL, AND THE PUBLIC 368
ENGINEER, THE, AND THE STATE 69
England and the U.S.A., Telephones in—T. F. Purves, A.M.I.E.E. 97
England, Some Observations on Telephone and Telegraph Practice in—Angus S. Hibbard 228

Factory, Holloway: Visit of North Metropolitan District Engineers 231
Faraday—Andrew Fraser 270
Faults, Cable, and their Removal: An Experiment 345
Fire Alarm System, New, for G.P.O. Buildings—E. V. Smart 135

G.P.O. Buildings, New Fire Alarm System for—E. V. Smart 135

HARTNELL, MR. H. 88
History, Early, of Wireless Telegraphy—J. E. Taylor, A.M.I.E.E. 20
HOLDSWORTH, J. G. 205
Holloway Factory: Visit of North Metropolitan District Engineers 231

INDIA, IN 370
INDUCTANCE OF TELEGRAPH APPARATUS 309
INSTITUTION NOTES 71, 195
INTERFERENCES, WIRELESS 192

PAGE
JOURNAL, ABOUT OUR 195
JOURNAL, NEW WIRELESS 194

LIBRARY, NEW BOOKS IN OUR 286
LIBRARY NOTES 285, 371
Library, Our, and One of the Books 188
LISTS, NEW 372
LITIGATION, WIRELESS 70
LOCAL CENTRE NOTES 74, 197, 284, 355
LODGE, SIR OLIVER'S PATENT FOR SYNTONISED WIRELESS TELEGRAPHY, EXTENSION OF 194
London, A Year's Telephone Progress in 24
London Telephone System in 1920, The: A Forecast—M. C. Pink 123
London Trunk Exchange, Pneumatic Distribution of Trunk Call Tickets in—H. P. Brown 209

MARCONIGRAPH, THE 370
Mechanical Analogies Applied to Radio-Telegraphy—F. W. Davey 140
METROPOLITAN CENTRAL BENEVOLENT SOCIETY 82
MILLIAMPÈRE METER AND VOLTMETER COMBINED 278
MITCHELL, MR. JOHN IRVING 93

National Telephone Co. *v.* H.M. Postmaster-General 177
New Forest, Telephones in 160
NEW IDEAS—
  A New Pole Test Box 15
  Bell Receiver 128
  A New Wall Telephone 275
  Voltmeter and Milliampère Meter Combined 278
  Protection of Transformers in Pole Test-boxes 341
NOTES AND COMMENTS 65, 192, 279, 347

OBITUARY—
  JOHN IRVING MITCHELL 93
  J. G. HOLDSWORTH 205
Ohm and his Law—Andrew Fraser 131

Pneumatic Distribution of Trunk Call Tickets in the London Trunk Exchange—H. P. Brown 209
Pole Chair, Replacing a—E. M. 269
Postmaster-General *v.* National Telephone Co. 177
POST OFFICE ENGINEERING DEPARTMENT—EIGHTH ANNUAL DINNER 49, 65
POST OFFICE ENGINEERS, CONFERENCE OF 65
POST OFFICE RADIO-TELEGRAPH SYSTEM, EXTENSIONS OF 279
POST OFFICE, SECRETARY TO 280
Preservation and Decay of Timber—W. H. Matthews, B.Sc. 162, 243, 300

PAGE

Problems, Cable 251
PUBLIC, THE, AND ELECTRICAL ENGINEERS 368
Putney Telephone Exchange Transfer to New Premises—
J. L. Taylor 326

RADIO-TELEGRAPH SYSTEM, POST OFFICE, EXTENSIONS OF 279
Radio-Telegraphy, Mechanical Analogies Applied to— F. W. Davey 140
RECEIVER, BELL 128
Rectifier, A Simple—Geo. Sutton 169
Reminiscences, Wayleave—W. W. Vyle 172
RETIREMENTS:
J. W. Woods 85
H. Hartnell 88
G. M. Carr 90
W. Brown 372
REVISION, THE 354

SCIENCE GUILD, THE BRITISH 192
SECRETARY TO THE POST OFFICE 280
Sketches in "Telegraph Street"—A. J. Stubbs 1
SLINGO, MR. W. 87
STAFF CHANGES 95, 206, 288, 375
STATE, THE, AND THE ENGINEER 69
STATION LIST SUPPLEMENT 287

Telegraph and Telephone Practice in England, Some Observations on, May and June, 1911—Angus S. Hibbard . . . 228
TELEGRAPH APPARATUS, INDUCTANCE OF 309
TELEGRAPH COMMISSION, ANGLO-BELGIAN, 1911 347
Telegraph Construction on the Canadian Pacific Railway—
E. A. LAKEY 152
"Telegraph Street," Sketches in—A. J. Stubbs 1
TELEGRAPHY, SYNTONISED WIRELESS, EXTENSION OF SIR OLIVER LODGE'S PATENT FOR 194
TELEGRAPH SYSTEM, RADIO-, EXTENSION OF POST OFFICE 279
Telegraphy, Radio-, Mechanical Analogies applied to— F. W. Davey 140
Telephone, Advertising the—John Lee 111
Telephone and Telegraph Practice in England, Some Observations on, May and June, 1911—Angus S. Hibbard . . . 228
TELEPHONE, A NEW WALL 275
TELEPHONE CABLE, LOADED, NEW ANGLO-BELGIAN 70
Telephone Exchange, Putney, Transfer to New Premises—
J. L. Taylor 326
TELEPHONE EXCHANGE SYSTEMS, AUTOMATIC 194
Telephone Progress in London, A Year's 24
Telephones in England and the U.S.A. — T. F. Purves, A.M.I.E.E. 97

PAGE
Telephones in the New Forest 160
Telephone System, The London, in 1920, A Forecast—M. C. Pink 123
TELEPHONE SYSTEM, TRUNK, FUTURE DEVELOPMENT OF, IN UNITED KINGDOM 67
Telephone, The, in British East Africa 117
Telephone Transmission Treated Graphically, with Special Reference to Non-uniform Circuits—A. G. Lee, B.Sc., A.M.I.E.E. 7
TEST-BOX, A NEW POLE 15
Timber, The Decay and Preservation of—W. H. Matthews, B.Sc. 162, 243, 300
TRANSFER, THE 355
Trunk Call Tickets, Pneumatic Distribution of, in London Trunk Exchange—H. P. Brown 209

Underground Cable Circuits, Fast-speed Wheatstone Working on—A. Fraser 321
Underground Plant, The Diversion of—J. E. Gibbons . . 289
UNITED KINGDOM, FUTURE DEVELOPMENT OF TRUNK TELEPHONE SYSTEM IN 67
U.S.A. and England, Telephones in—T. F. Purves, A.M.I.E.E. 97

VOLTMETER AND MILLIAMPÈRE METRE COMBINED 278

Wayleave Reminiscences—W. W. Vyle 172
Wheatstone Fast-Speed Working on Underground Cable Circuits—A. Fraser 321
Wire, Enamelled—W. B. Smith, A.I.E.E. 259
WIRELESS INTERFERENCES 192
WIRELESS JOURNAL, NEW 194
WIRELESS LITIGATION 70
Wireless Telegraphy, Early History of—J. E. Taylor, A.M.I.E.E. 20
WIRELESS TELEGRAPHY, SYNTONISED, EXTENSION OF SIR OLIVER LODGE'S PATENT FOR 194
WOODS, MR. J. W. 85

INDEX TO AUTHORS.

PAGE
A. E. C. 85
A. J. S. 375

Brown, H. P. 209

Christensen, P. V. 338

Davey, F. W. 140
D. H. K. 188

E. M. 269

Fraser, Andrew . 41, 131, 270, 321
F. T. 372

Germann, Thomas 30
G. F. O. 251
Gibbons, J. E. 289

Hibbard, Angus S. 228
Hills, Stanley M. 30
Hines, J. G. 262

J. S. B. 160

PAGE
Lakey, E. A. 152
Lee, A. G., B.Sc., A.M.I.E.E. . . 7
Lee, John 111

Matthews, W. H., B.Sc. 162, 243, 300

Ogden, E. 156

Pink, M. C. 123
Purves, T. F., A.M.I.E.E. . . 97

R. J. L. 345

Smart, E. V. 135
Smith, W. B., A.I.E.E. . . . 259
Stubbs, A. J. 1
Sutton, Geo. 169

Taylor, J. E., A.M.I.E.E. . . 20
Taylor, J. L. 326
T. H. N. 93

Vyle, W. W. 172

Engineering Staff on the North Wales District—Liverpool.

THE
Post Office Electrical Engineers' Journal

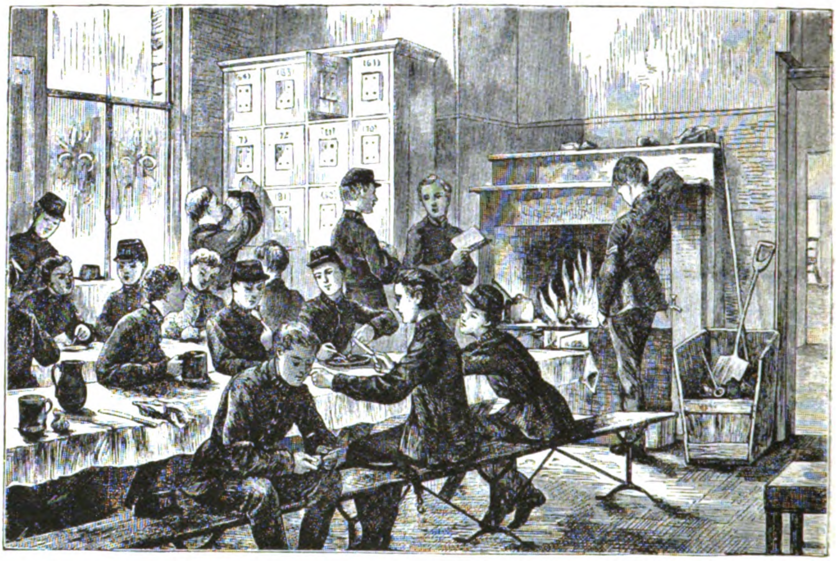
SKETCHES IN "TELEGRAPH STREET."

By A. J. Stubbs.

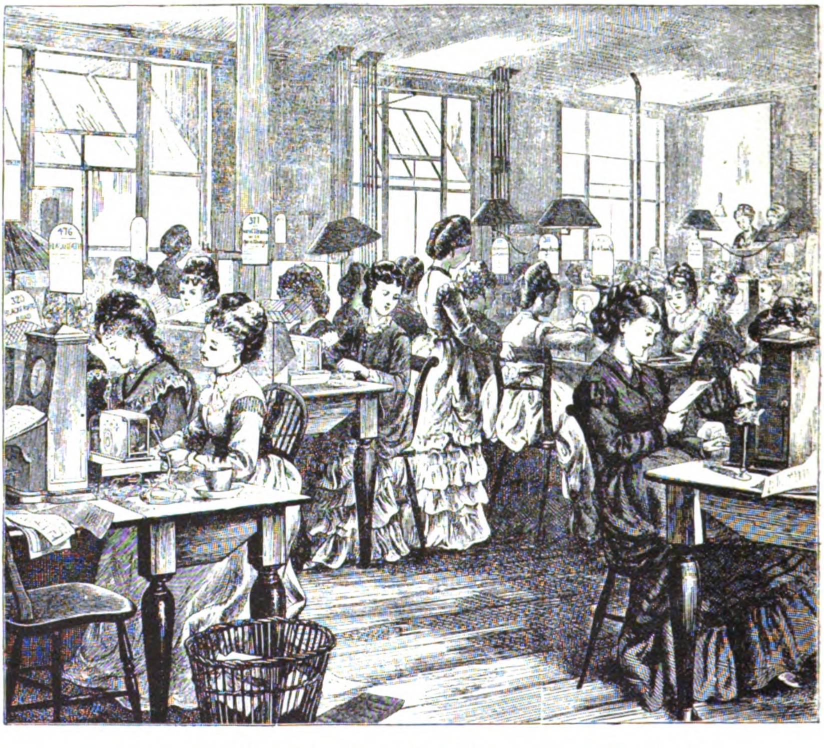
T.S. in 1871! It really was "T.S." (Telegraph Street) then. I wonder if any of the ladies sketched in the Metropolitan Gallery forty years ago can be recognised by any of their present-day successors. Strange to think that even in those days the "Gallery" was not a gallery, and that still the name remains to remind us of "the old Companies' days" that are almost prehistoric.

It is interesting, in reading the "Jottings about Telegraph Street," in connection with which the 'Graphic' sketches which we reproduce were made, to notice that, "When the Post Office first took the telegraphs out of the hands of the companies dire forebodings were uttered and croakers prognosticated all sorts of inconveniences, and, perhaps, a grand breakdown. They were disappointed . . . the new *régime* has worked admirably, and loud would be the lamentations had we to return to the old system . . ." Is history repeating itself? The croakers of those days were surely not louder or more dogmatic than the croakers of these? We must hope that they croaked no less wisely, and that what the 'Graphic' then called "the busiest of Government offices" may yet again demonstrate its power of work and of organisation, by disappointing the croakers when it proceeds to the task of doing for telephony, what it did for its parent telegraphy, more than forty years ago.

The scribe of 1871 found the lines from all parts of the United Kingdom, and of the Metropolis, concentrated in two enormous rooms, one of which—the Provincial Gallery—covered an area of 6000 square feet, fitted up with 178 instruments of all sorts. He mentions the Single Needle, Bright's Bell, "Morse's instrument—where the message, a mass of dashes and dots, is stamped on a strip



TELEGRAPH STREET, 1871. THE BOYS' KITCHEN.



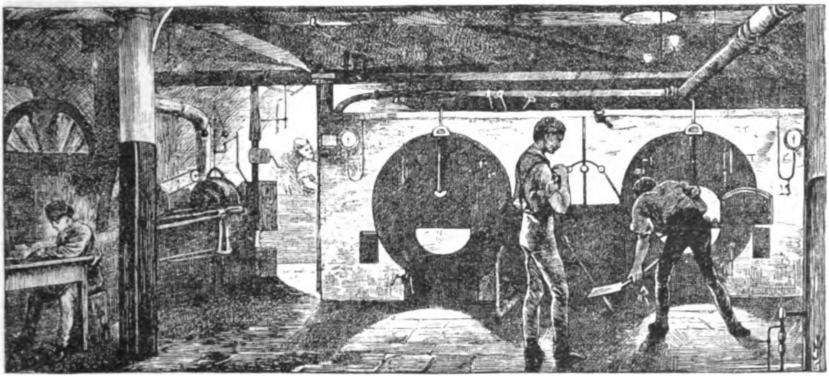
TELEGRAPH STREET, 1871. THE METROPOLITAN GALLERY.

of paper,"—an ABC instrument, the Hughes's type-printer, and—the "quickest instrument,"—the Wheatstone automatic. He does not mention its speed.

The staff of the Metropolitan Gallery was stated to number 256; the number of instruments being 217.

The treasured right of the present-day operator to "his or her salary" has doubtless been handed down from those old days together with the privilege peculiar to T.S. that "every operator is supplied *gratis* with a daily allowance of tea and bread and butter."

As I write I have before me a plan of T.S. in 1873. It had then removed to larger and more convenient premises at St. Martin-le-Grand. The plan shows the third floor, where accommodation was provided not only for the Provincial and Metropolitan galleries (with test-box, instrument store, check table, and pneumatic tubes), but also for cloak rooms, dining rooms, kitchen, lavatories, stationery store, day and night superintendents' rooms, subcontroller's and mechanics' shop, and even for the offices of the Superintending Engineer, Mr. Eaton, and his staff. The female "senior clerks" had a separate dining room, but there is no sign that the male "clerks" were similarly favoured.



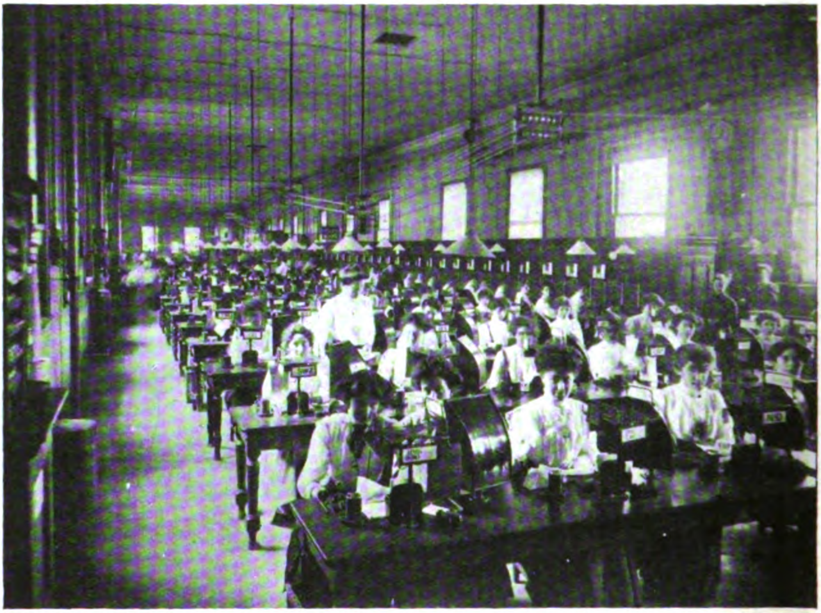
TELEGRAPH STREET, 1871. THE ENGINE ROOM.

Those who know T.S. now, in its decadence, when its strength has been filched by the telephone, will be interested to hear of its extent in the heyday of its youth.

In those days the total number of persons connected with T.S. consisted of 317 male and 539 female clerks, and 182 messengers—in all 1038. Mr. Newlands tells me that he has a staff of 2370 males and 1074 females, supplemented by over 165 paid learners, and that the T.S. tube attendants, boy messenger, commissionaires, etc., make a further total of 887—practically 4500, exclusive of season assistants.

The view given of the present Metropolitan Gallery suggests more convenient working conditions. It gives a distinct view of the the concentrator switch, which has done so much to simplify the handling of traffic between Metropolitan offices, and incidentally to reduce the staff required for the purpose.

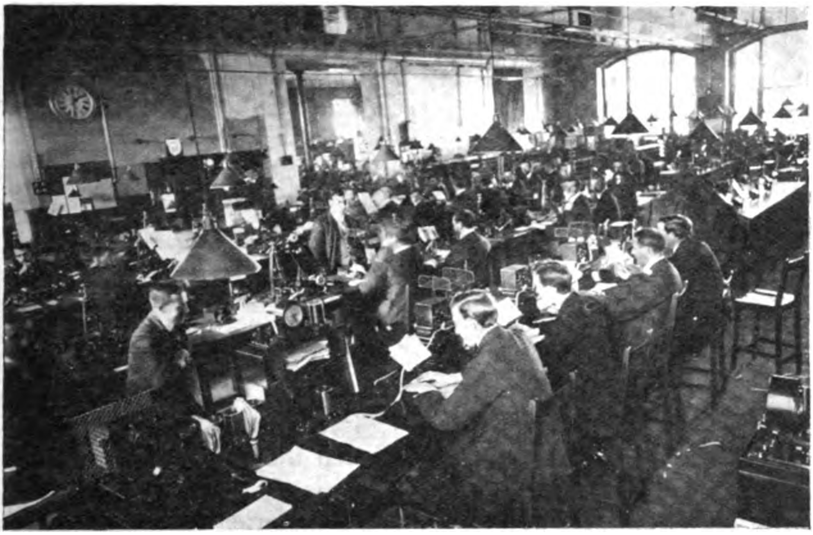
Apparently even in those days the "blind-alley" difficulty was dimly foreseen, and the "little fellows paid a penny per message" were being superseded in one respect by "machinery erected for carrying messages between the various departments of the building." This was the tape-carrier shown in the sketch of the Metropolitan Gallery—the prototype of the present-day cord-carrier shown in the C.T.O. Metropolitan Gallery, soon, perhaps, to be superseded by a more intelligent "mechanical messenger," which will both collect and distribute messages, and assist the Boy Messenger Committee to dispense with some of the little fellows in instrument rooms whose earnings do *not* "depend in a great measure upon their own speed and industry!"



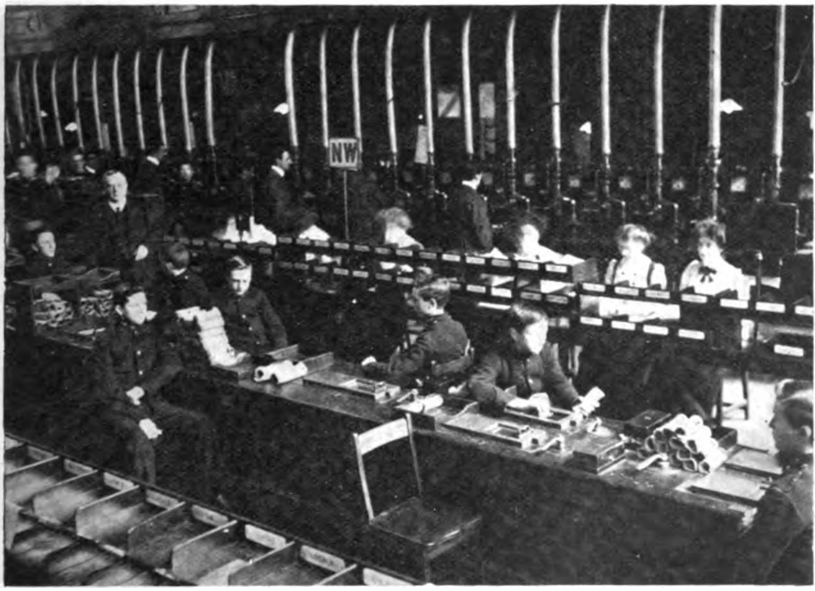
1911—THE METROPOLITAN GALLERY.

The tape carrier was shown in a previous number of this JOURNAL (vol. 2, p. 51), and may be seen also in the picture of T.S., Metropolitan Gallery, in 1871.

It is difficult to estimate what would have been the number of messengers required if the tube system had not been developed. The boys shown working the short tubes in the Central Hall can sit at their messenger duties, and effect an enormous amount of distribution with comparatively little exertion. The present-day T.S. tube system also had its origin in those far-off days, but it has grown and developed almost beyond recognition.



1911—The Foreign Gallery.



1911—The Central Hall.

The boys' kitchen in Telegraph Street is shown in another sketch. There were no Messengers' Institutes then, no drill, no library, no many-things, but even then they had "fire and lights found them, and they are allowed to cook their own dinners, the material for which, however, they bring themselves."

Ancient and modern history are surely twins! Who was the lord of all these great things in those far-off days? Has ye gentle reader ever heard of the "Right Hon. William Monsell, of Terroe, County Limerick, M.P.?" Until his time, "with the exception of Lord Hartington, who was the eldest son of a peer, the office of Postmaster-General had been held by none under the rank of a peer since the resignation of Lord Montague in 1827." And "the man who has been the chief organiser of this new system, Mr. Frank Ives Scudamore, C.B.," was the Secretary of the Post Office.

When, "forty years on" (as one of our public school songs says), some contributor to the 'Graphic' returns the compliment and extracts from our JOURNAL pages of to-day, he will probably be interested to know that at the time when the telephone system was unified under the Post Office and became "National," the ruling Postmaster-General was the Right Hon. Herbert Samuel, M.P., a member of the Cabinet, and that the Secretary was Sir Matthew Nathan, G.C.M.G., who was previously the last Governor of Natal.

[The sketches on pages 2 and 3 are reproduced from the 'Graphic' by special permission of the proprietors, to whom we express our thanks.—EDS.]

ERRATUM.

IN the article on "Telephone Management in Large Cities" in our January number, the expression given on p. 306 as—

$$N = \frac{3600}{t} \cdot p^{-\left(\frac{V-C}{t} + m - 0{\cdot}5\right)}$$

should read—

$$N = \sqrt[\frac{V-C}{t} + m - 0{\cdot}5.]{\frac{3600\,P}{t}}$$

TELEPHONE TRANSMISSION TREATED GRAPHICALLY, WITH SPECIAL REFERENCE TO NON-UNIFORM CIRCUITS.

By A. G. Lee, B.Sc., A.M.I.E.E.

(*Continued from vol.* 3, *p.* 318.)

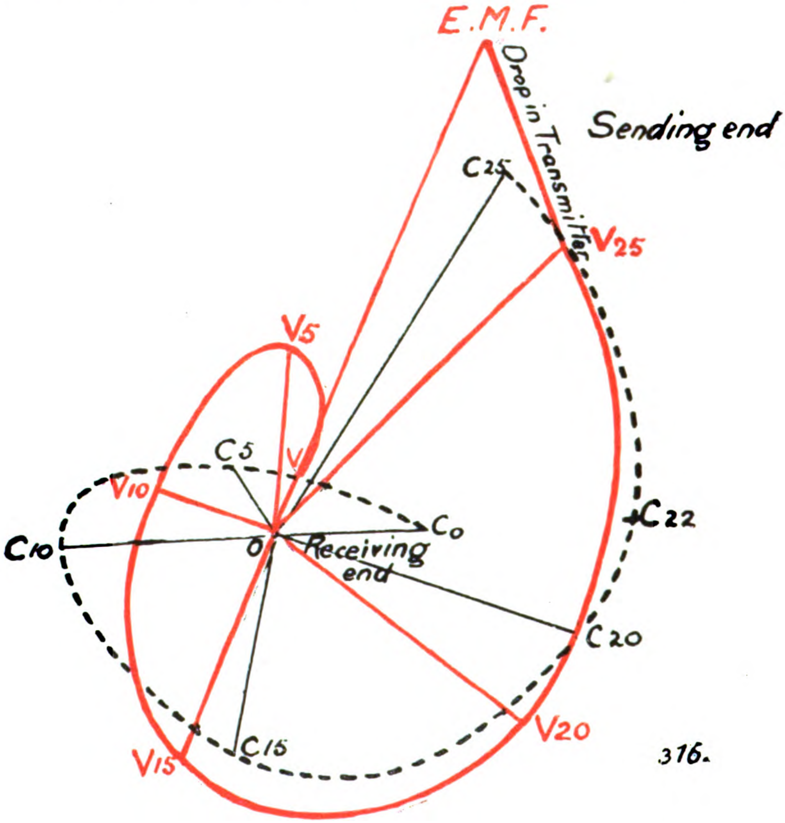
Mr. B. S. Cohen, in a paper read before the Institution of Electrical Engineers in 1907, gave the results of some measurements on telephone cables, and he showed that for a length of four or five miles of cable the current sent out was much less than that received. A similar result has been obtained more recently by M. Devaux Charbonnel in France. The curve given in **8** shows the same result, and it indicates that the empirical formula on which the "Equivalent" method of comparing circuits is based, viz.:

$$C_r = C_s \ e^{-ax}$$

Where C_r = received current,
C_s = sent current,
a = attenuation constant,
x = length of line,
e = base of natural logarithms,

is incorrect for short lengths of circuit, because by this formula C_r must always be less than C_s.

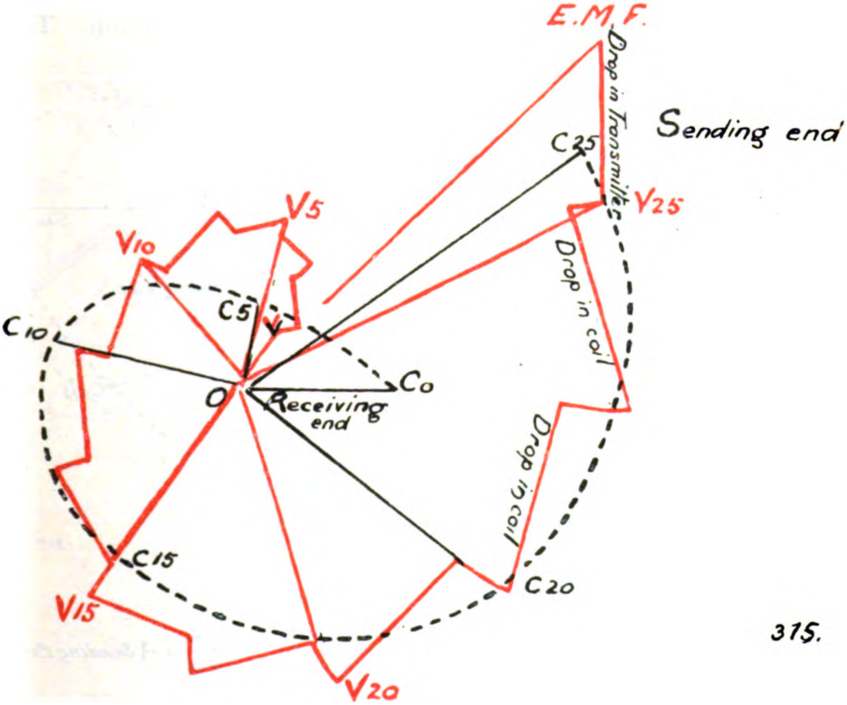
The curve shows also the immense effect of attenuation, and the manner in which both current and voltage change in phase as the sending end is reached, or perhaps it should be put the other way about, that they change in phase in travelling from the sending to the receiving end. This change of phase is merely an indication that time is necessary for the transmission of telephone signals along a line. If the phase displacement between the E.M.F. and the received current is, say, 360°, then if the frequency be 750 ~ per second the current is received exactly $\frac{1}{750}$th of a second after it is impressed on the circuit. Distortion results if the harmonics do not travel at the same rate as the fundamental, hence the phase displacements for different frequencies give us a practical measure of distortion. Authorities differ as to the cause of distortion. Helmholtz, in his work on musical sounds, proved that phase displacement of the harmonics did not cause distortion. On the other hand Lord Kelvin has shown that phase displacement of imperfect harmonics produces distortion, and it has been stated by V. Karpen (‘Comptes Rendus,’ November 15th, 1909), that with telephone currents phase displacement is of more importance than attenuation of the harmonics in producing distortion. As the harmonics in a man's voice are usually of much greater amplitude than the fundamental, it is extremely probable that the last authority quoted is correct in regard to telephone currents.



9.—20-lb. Cable, twenty-five miles in length, with Inductance of 0·05 Henry Uniformly Distributed. $Z_{SE} = 955^{\omega} \mid 13^{\circ}$. $Z_t = 3260\omega \mid 421^{\circ}$.

9 shows a loaded 20-lb. cable with inductance assumed to be uniformly distributed. It will be seen that for a line twenty-two miles in length the received current is 360° out of phase, showing how much slower the current travels on a loaded than on an unloaded circuit. Compare with **8** in this respect.

10 shows the same cable actually loaded with coils at 2-mile intervals. The inflexions in the voltage curve show the change of voltage at the coils, but the effect of the reflections on the current curve is *nil*, and the impedance is the same as in the last case.

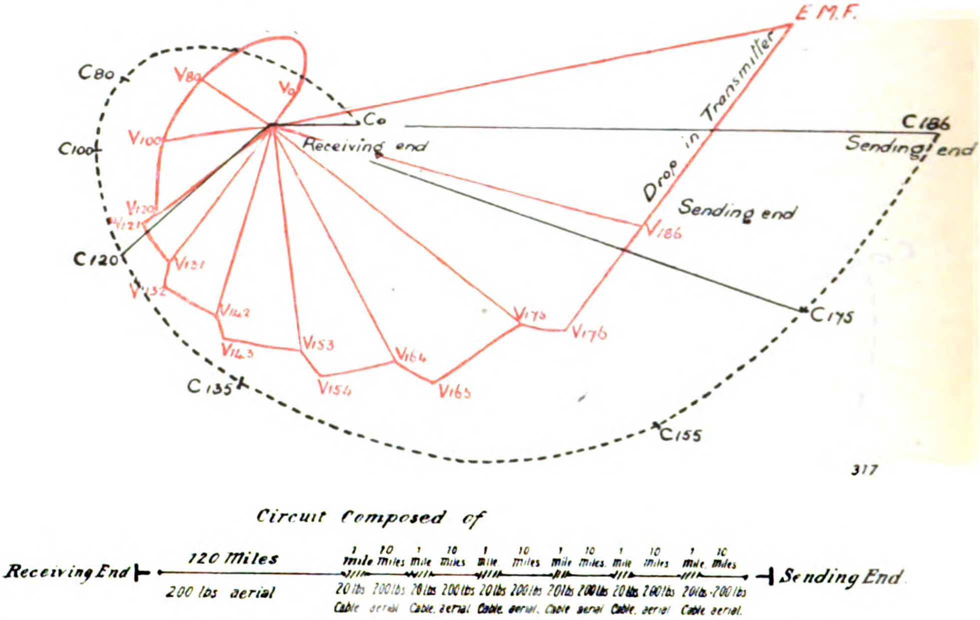


10.—20-LB. CABLE, TWENTY-FIVE MILES IN LENGTH, WITH INDUCTANCE COILS OF 0·01 HENRY EACH AT 2-MILE INTERVALS. $Z_{SE} = 1000^{\omega} \overline{|7^{\circ}}$. $Z_{t} = 3300 \underline{|404^{\circ}}$.

11A and **11B** show curves drawn to determine the effect of the insertion of a length of 20-lb. cable in a trunk open-line circuit. In **11A** the cable is split up into short sections with aërial line in between. In the curves in **11B** the cable is in one section. The lengths of cable in **11A** are too short to produce much reflection, and their capacity is probably neutralised to some extent by the aërial line sections in between. The latter act somewhat like small inductance coils in improving the transmission. The cable and aërial line "equivalents" are mixed, producing a smaller "equivalent" than the sum of the separate equivalents. This effect probably takes place at all junctions of aërial lines with cables and tends to neutralise the effect of reflection.

In **11B** the current curve shows reflection, but as the sending end impedance is higher there is less drop in the sending-end apparatus, and the net difference between the arrangements is small. The advantage is, however, on the side of **11A.**

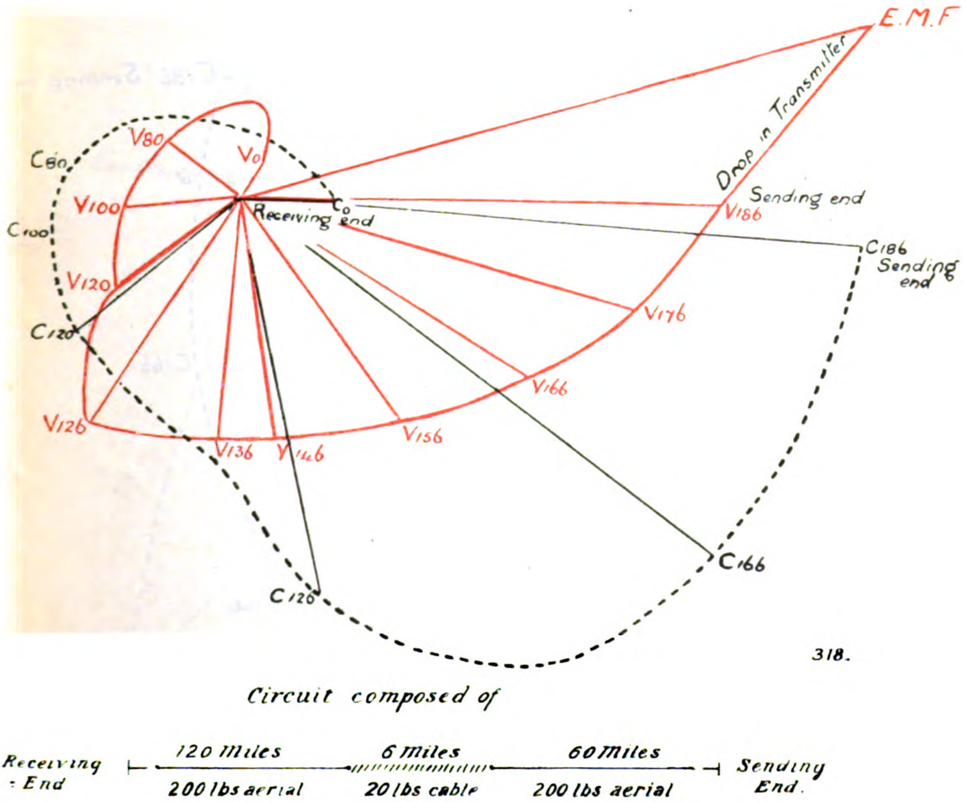
12 shows a six-mile section of 20-lb. cable in the middle of a trunk line. An inductance is inserted at each end of the section. The improvement due to this cause is marked. The inductance coil could be incorporated in the protective fitting at each end when it is not desired to load the whole cable.



11A.—$Z_{SE} = 575^{\omega} \mid 15^{\circ}$. $Z_t = 5900^{\omega} \mid 371^{\circ}$.

13 shows a section of aërial line with ten miles of cable at each end. The section of aërial line is equivalent to 2·72 miles of standard cable. This is too short to produce any serious reflection, but it acts very much like a small inductance coil placed in the middle of the circuit, on account of its relatively lower capacity and higher inductance as compared with standard cable. There are, then, two effects, its reflection and its inductive effects opposing one another. **13A**, drawn with rectangular co-ordinates, shows the effect more clearly. It will be seen that the line impedance for a length of 30 miles is less than the impedance for ten miles. (Note: The voltage curve is also a curve of impedance.) The net result is small, about 3 per cent. in favour of the mixed circuit as compared with its equivalent in standard cable.

In regard to the subject of reflection, it is found in practice that reflection can be neglected on unloaded circuits. This can be seen from the curves to be due to any of the following causes:



IIB.—$Z_{SE} = 768^{\omega}\ \underline{|\,3^{\circ}}$. $Z_t = 6900^{\omega}\ \underline{|\,376^{\circ}}$.

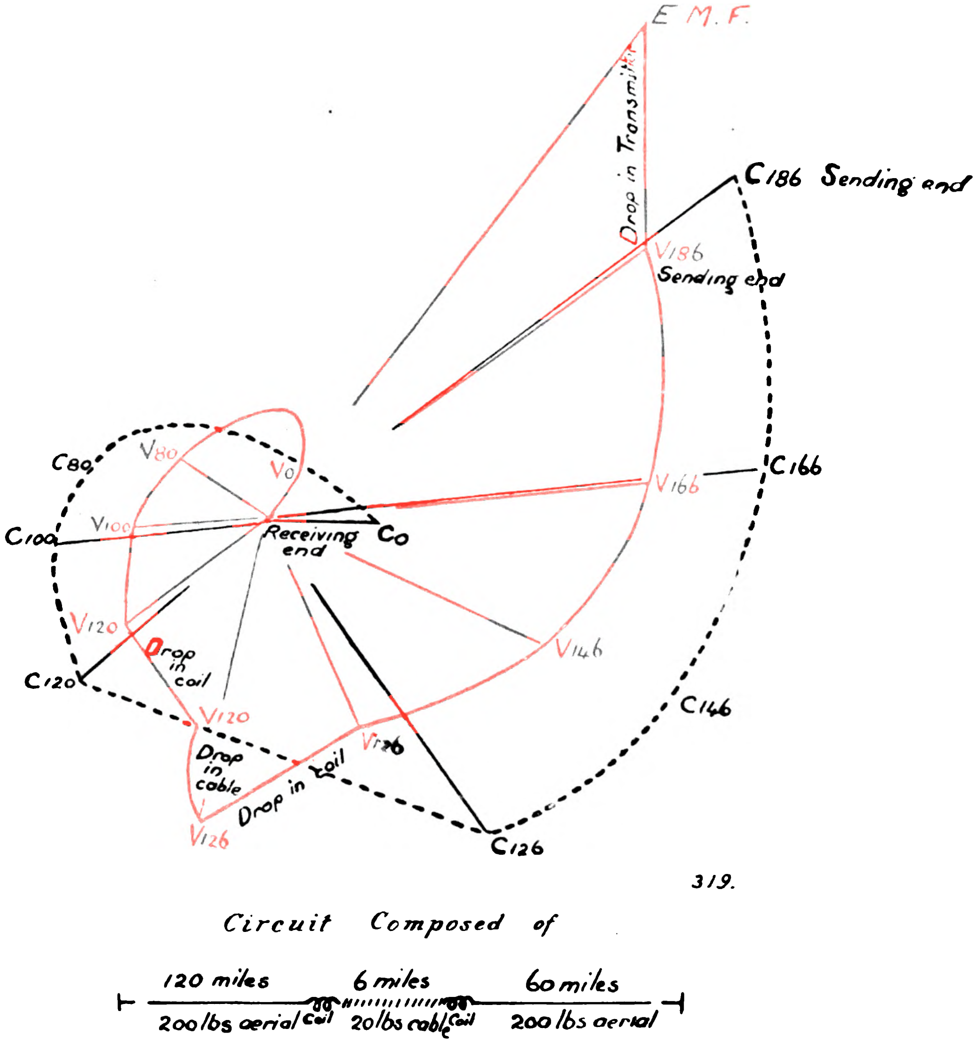
(1) If the lines are short comparisons with standard cable are difficult, and the terminal effect swamps the effect of the line. On a line of four miles of 20-lb. cable the "equivalent" really has a negative value. It would, however, not be observed by the aural method of comparison.

(2) If the lines are long, the line impedance is large in comparison with the loss due to reflection at junctions, and the effect is not felt.

(3) If the sections of cables are short, reflection is negligible.

(4) The mixture of the "equivalents" at the points of junction is beneficial and counter-balances the effect of reflection.

If one mile of 20-lb. cable and one mile of 200-lb. copper aërial be combined, and it is assumed the electrical constants, capacity, etc.,

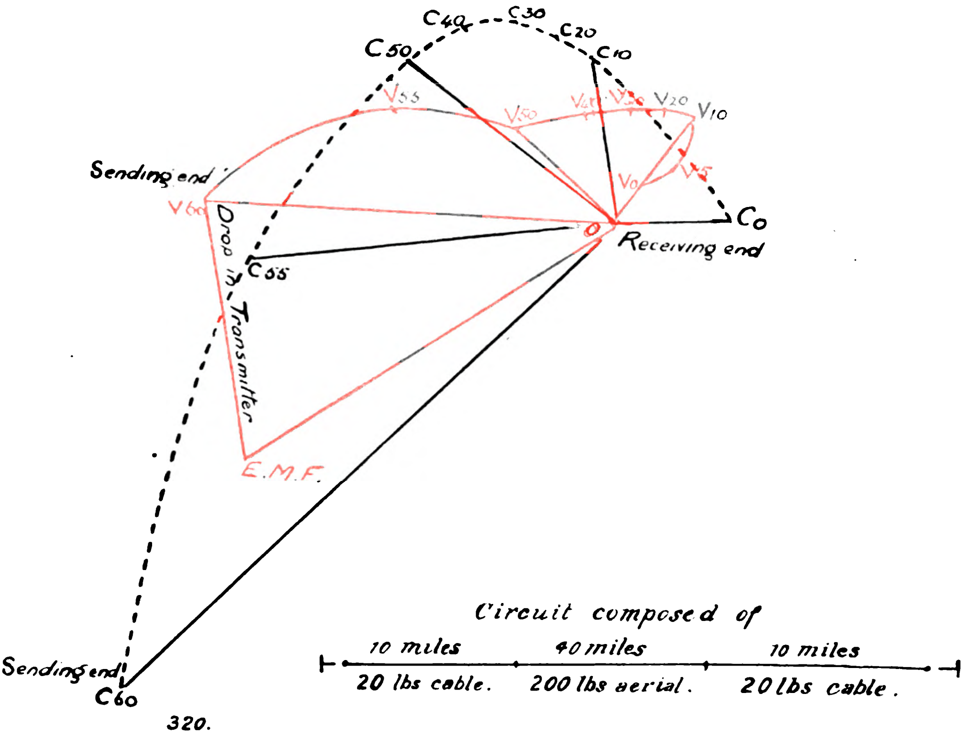


12.—$Z_{SE} = 804^{\omega} \,|\overline{1^\circ}$. $Z_t = 5650 \,|\underline{413^\circ}$.

are mixed, then the equivalent of the mixture is 1·046 as against 1·068 obtained by adding the separate equivalents. If it is assumed that five miles of aërial is mixed with one mile of cable, then the equivalent of the mixture is 1·236 as against 1·33 given by the sum of the equivalents.

On loaded lines the effects of reflection are more serious, and this subject is one which is under investigation.

The figures concerning the electrical constants of the telephone apparatus used in the calculations given in this paper are only assumed, and the curves given must not be taken as absolute. They are rather guides to what happens in the different circuits described.



13.—$Z_t = 3810^{\omega} \mid \underline{210^\circ}$.

APPENDIX.

On the Variation in E.M.F. in a Telephone Induction Coil with Change of Load in the Secondary Circuit.

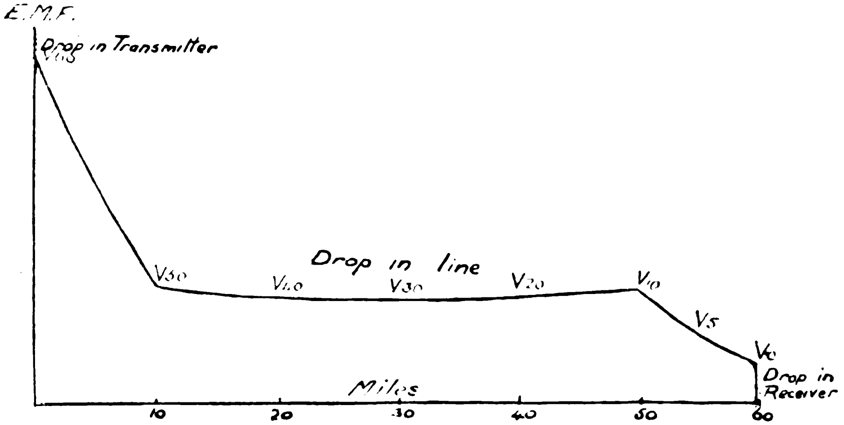
Investigation into the "impedance" method led me to the conclusion that the E.M.F. was not the same on different circuits and on different lengths of the same type of circuit. By the "impedance" method is meant the method of comparing efficiencies by means of the total impedance of the circuits.

It is explained by the fact that owing to magnetic leakage, and the reaction of the secondary current upon the primary circuit, the E.M.F. falls as the load increases.

A cable circuit has large capacity and therefore takes a large current, with a consequent large drop in the E.M.F. The amount of the drop, however, depends on the phase of the current at the sending end with respect to the E.M.F.

I have allowed for the drop between the E.M.F. and the P.D., that is, the simple impedance drop in the secondary, in giving the total impedance, but the drop in E.M.F. due to load has to be allowed for by a co-efficient.

Assuming certain figures for the induction coil, I have determined, by an application of Bedell's transformer diagram, the ratio of the E.M.Fs. on the following circuits:



13A.—Impedance Curve. Rectangular Co-ordinates.

Cable.	Ratio of E.M.F.
10 lb.	1·05
20 ,,	1·00
100 ,,	·925
150 ,,	·948
200 ,,	·978
Aërial copper.	
100 lb.	1·285
200 ,,	1·358
600 ,,	1·462

It will be seen that the correcting factors are large and the matter requires experimental determination.

The total impedance when corrected by the above ratios agrees very well with results obtained in practice. The importance of this investigation lies in the fact that if a more perfect induction coil were designed, *i.e.* one in which the drop in E.M.F. with load is small, then better results would be obtained on cable circuits. Probably the simple equivalent theory would no longer hold good in this case, and we should be obliged to resort to a more complicated method of comparing efficiencies. The "equivalent" theory only holds the field to-day by reason of the remarkably poor efficiency of the induction coil considered as a transformer. For the reason therefore, that the "impedance" method may point the way to improvements in the induction coil, it is, I think, worthy of study.

NEW IDEAS

A NEW POLE TEST-BOX.

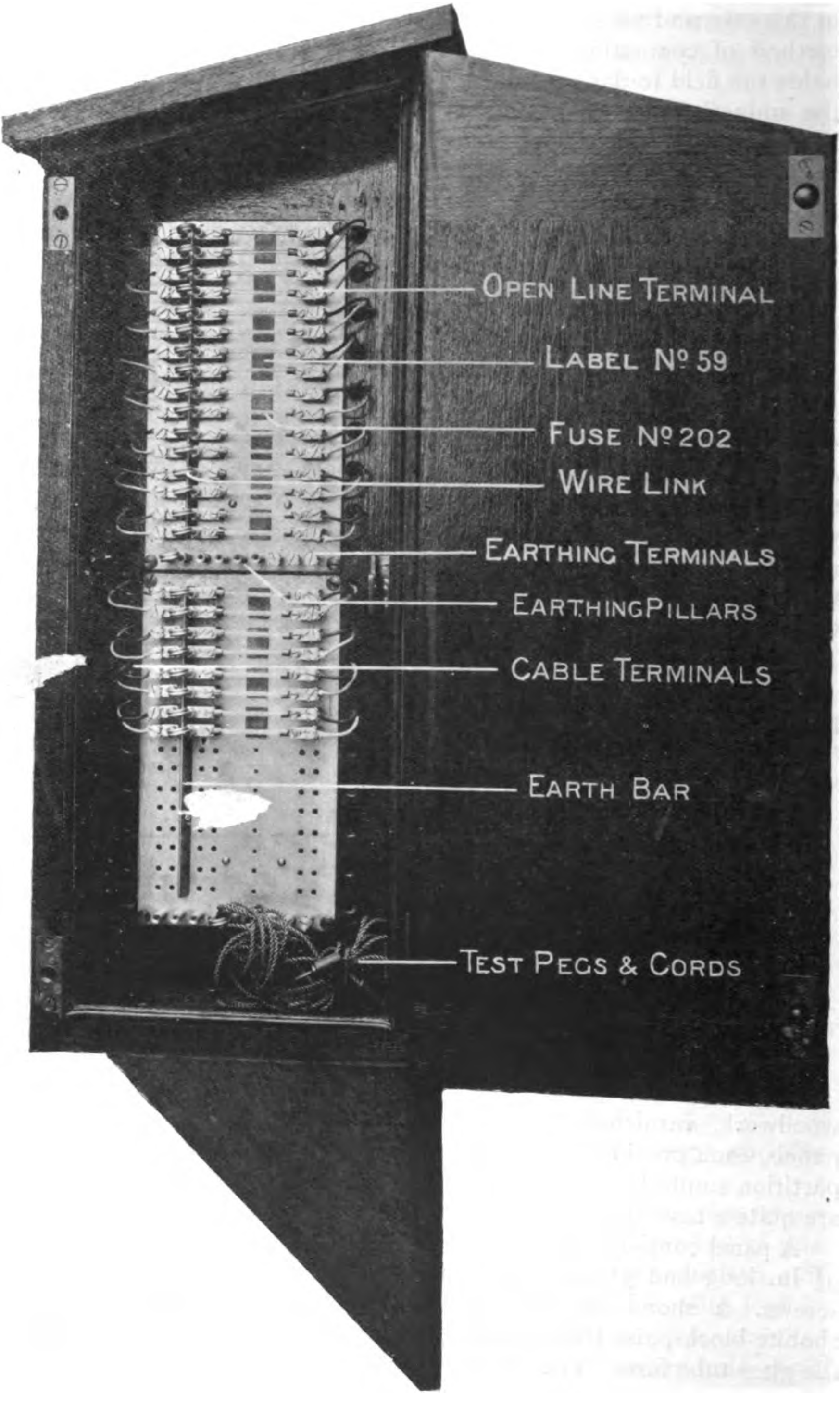
Considerations of space enter very largely into the question of suitable design of modern telephone and telegraph apparatus. The design of existing plant may be satisfactory in every way except in the one particular that the space occupied by the units forming the whole is too great, and consequently development in regard to accommodation cannot continue without introducing unwieldiness. In this connection it has become necessary to alter the design of pole test-boxes, and a new type of box which will be known as "Pole Test-box G" has therefore been introduced.

The former standard was the well-known "E" box which provided facilities for testing and protection against lightning and strong currents. The following table shows the saving in length which has been effected:

	Length of	
No. of wires accommodated.	Box E.	Box G.
16	49½ inches	24½ inches.
32	69½ ,,	34 ,,
48	89½ ,,	44 ,,
64	109½ ,,	54¼ ,,
80	129½ ,,	64 ,,
96	— ,,	74½ ,,

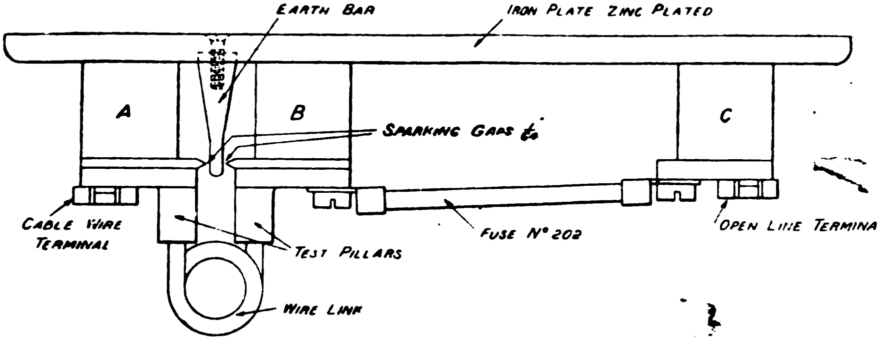
1 illustrates a 32-wire box which consists of the usual teak woodwork, varnished inside and painted outside. Two similar panels, each providing for 16 wires, are fitted on a framed internal partition similarly placed to that of the "E" box. These panels are quite a new departure, and will therefore be described in detail.

A panel consists essentially of a $\frac{3}{16}$ in. iron plate, zinc plated, 9½ in. long and 5½ in. wide, suitably drilled for the various fixing screws. **2** shows in plan the method of insulating the wires by ebonite blocks, also the earth bar, the spark gaps, the wire link, and the glass tube fuse. The ebonite blocks are ⅝ in. long, ⅝ in. deep,



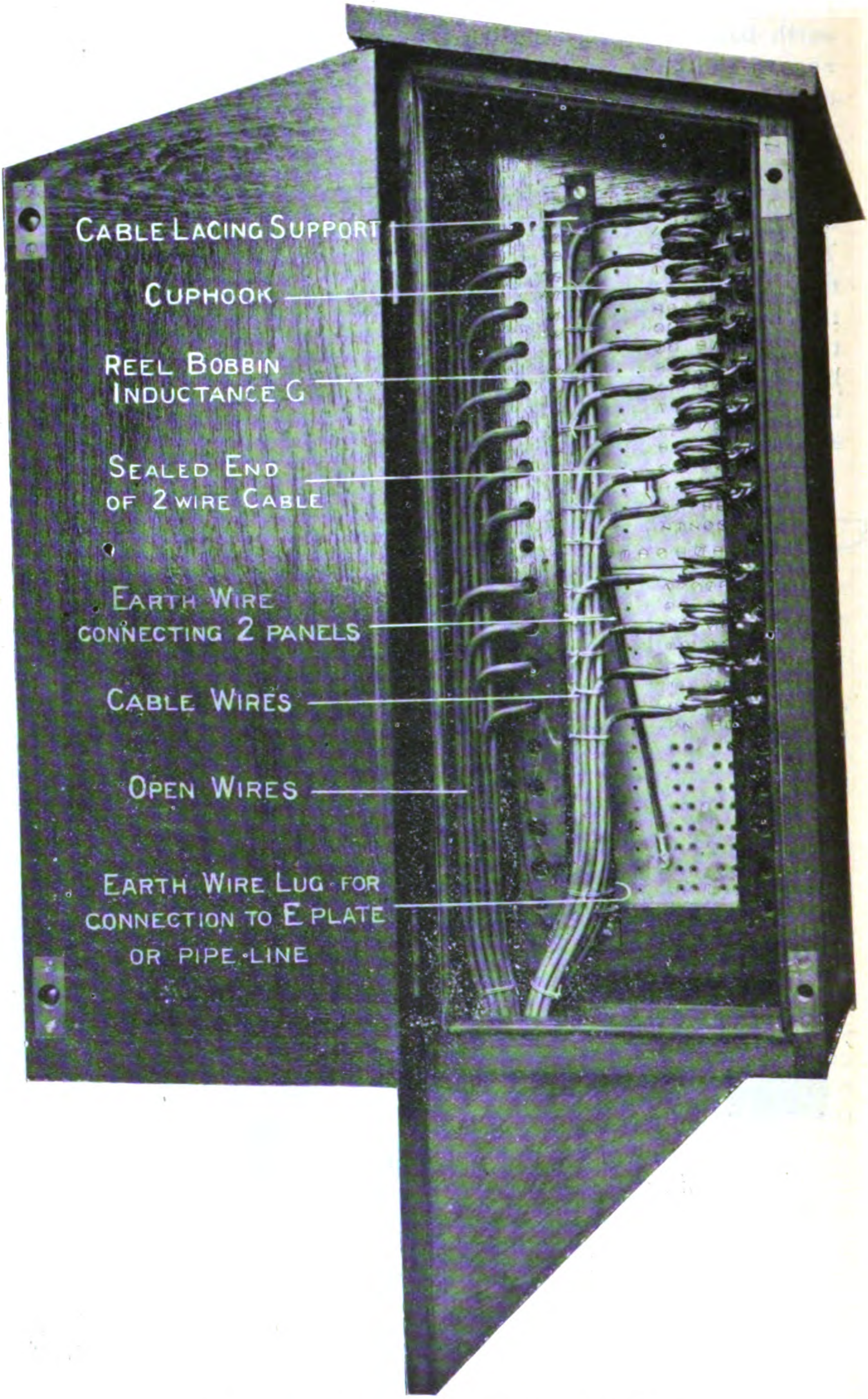
I.—Pole Test-box for 32 Wires. Front View.

and $\frac{5}{16}$ in. wide. The blocks A and B, fixed at each side of the earth bar, have projecting tinned brass pieces which are wedge-shaped and knife-edged on the $\frac{5}{16}$ in. edge. The edges are polished and separated by $\frac{1}{64}$ in. from the brass earth bar, which also is polished at the sparking gaps. It will be readily understood that this combination forms a lightning protector, which, though not to be considered as efficient as a carbon plate protector, is nevertheless expected to be sufficiently sensitive to meet the circumstances of use. The ebonite block marked "A" carries a crown cup terminal for the purpose of binding a wire from the main cable, and a test-hole; that marked "B" has a test-hole, and a screw terminal for binding the forked end of a glass tube fuse; whilst the block marked "C" has a screw terminal and crown cup terminal only. The test-holes are bridged by means of a tinned copper wire link similar to the wire links supplied for use on trunk switch sections. The fuse, which is known as Fuse No. 202, is rated to carry 2 ampères, and to fuse at 3·5 ampères. Labels No. 59 are fixed below each pair of fuses for identification purposes. Six brass earthing pillars and three crown cup earthing terminals are provided near the bottom edge of each plate; the former are for connecting wires to earth by means of test plugs and cords, the connection being from a test-hole to an earthing pillar, the latter for the purpose of earthing an open wire direct—that is, eliminating the fuse from test by an insulated wire connection between the crown cup terminal on the block marked "C" and one of the earthing terminals.



2.—PLAN OF INSULATING BLOCKS, WIRE-LINK AND FUSE.

1 is not quite up-to-date, being a photograph of an experimental box. It has been decided to keep the iron panels entirely separate and to shelter each with an internal sheet-iron cover on the testing side; also, to issue the panels completely fitted with fuse mountings. The stock title of a fully fitted panel is "Protector, Fuse and Test No. 1601." It may happen that it is desirable to fix a test-box for


Cable Lacing Support
Cuphook
Reel Bobbin Inductance G
Sealed End of 2 wire Cable
Earth Wire connecting 2 panels
Cable Wires
Open Wires
Earth Wire Lug for connection to E plate or pipe-line

3.—Pole Test-box for 32 Wires. Rear View.

an ultimate requirement of, say, 48 wires, whilst the number of wires to be accommodated at the time of fixing is, say, only 24. In such a case a box will be issued fitted with two "Protectors, Fuse and Test No. 1601" and iron covers, whilst the third panel position wil be filled by a ¼-in. wood panel. Temporary cross-connections will be made on the front of the box from one panel to another by means of special short pegs with cords. The temporary cross-connections from one panel to another will, to a slight extent, interfere with the replacing of the covers, but these connections are so seldom wanted that this point is a very small one. **3** shows the back of the test-box. Hitherto, in order to form inductance spirals for the better protection of paper-insulated cables, india-rubber-covered wire, electric light type, has been used for cable potheads at pole test-boxes. In the new test-box provision has been made for the use of small lead-covered india-rubber and cotton cables, two-wire, for such potheads. The cable pothead will be made in the usual way, but in addition to the length of cable required normally to reach from the main cable to the test-box terminals, 5 ft. extra should be allowed. The extra 5 ft. of cable should be stripped of its lead covering, and the sheathing securely sealed with Chatterton's compound, as illustrated. The flexible wires should then be passed through a hole in the cheek of a Reel Inductance, Type G, and a few turns taken before the wires are led out to a cuphook, and thence through the hole in the partition to the terminal on the front of the box. The connection from the cable to the open wire is made, through the wire link and fuse, to two-wire lead-covered cables (similar in every way to those used for the pothead), whose ends in the box are also plugged with compound. These cables pass through holes in the woodwork to the back of the box, and thence through the bottom and back of the box and wood casing to the sealing chambers of "leading-in insulators." Two earth-wire connection lugs are provided for each panel. A $\frac{7}{16}$ in. stranded copper wire should be soldered to the lug beneath the L-shaped iron cable lacing support on the lowest panel and connected to an earth plate buried at the foot of the pole, or connected by means of a bonding bolt or clip to the pipe line. The next panel above is connected by a staggered formation, as illustrated. The reels and fuses are separate items for requisition purposes.

THE EARLY HISTORY OF WIRELESS TELEGRAPHY.

By J. E. TAYLOR, A.M.I.E.E.

(*Concluded from vol.* 3, *p.* 351.)

SYNTONISING OF COHERER RECEIVER.—During the earlier investigations with receiving oscillation transformers, prior to the Holyhead-Howth experiments it had always been found desirable to use small gauges of wire for winding the secondary coil. Usually these coils were constructed with a single-layer divided secondary winding of from 1 in. to 2½ in. diameter, 5 mils silk-covered copper wire being found appropriate. The comparatively high resistance of such a winding produced considerable damping, and though this was appreciated it had not been found advantageous to increase the gauge of wire by reason of the loss of efficiency due to increased capacity of the winding as a whole when heavier gauges were used. Moreover, so long as little or no resonance was developed in the secondary circuit a certain amount of damping assisted rather than opposed the production of maximum potential difference between the outer extremities of the winding, for the reason that a damped circuit can be set in forced vibration more readily than an undamped circuit. Concurrently with the production of more highly syntonised methods of transmitting, the advantages of reducing the damping by increasing the size of the oscillation transformer and using heavier gauges of wire manifested itself. The necessity for accurate adjustment of the inductance and capacity constants of the circuits at the same time also became much more apparent. For these appliances it was ascertained that secondary windings of gauges up to 18 or 20 mils copper wire wound in a single layer on tubes or cylinders 3 in. to 6 in. diameter could be used. With wave-lengths of the order of 1000 ft. (as used in these tests) windings of 14 mils. single silk-covered wire gave very good results. Other types of winding with mixed gauges of wire heavier in the centre and decreasing in gauge towards the ends were also devised and gave a slight advantage over the uniform windings. With these resonant secondary windings an adjustable sliding glass tube capacity connected directly between the ends of the secondary winding served to accurately adjust the "tune," and at the same time gave appreciably greater sensibility to the coherer receiver, probably partly by reason of obscuring the effects of small changes of capacity in the coherer itself, and partly by reason of increased syntony by obscuring the effects of distributed capacity in the windings. A coupling reaction is also probably concerned. Suitable types of oscillation transformers for other classes of detector such as the carbon-steel detector were also devised. Variable coupling of the transmitter and receiver were not introduced at this date, but were independently discovered and utilised by the writer at a rather later stage (early in 1905). The theory and early stages of application of this principle by German investigators had, however, somewhat preceded this date.

REDUCTION OF DAMPING LOSSES.—That the use of solid copper or other metallic conductors in making up inductance spirals and similar appliances in wireless telegraphy practice was a source of appreciable loss of efficiency appears to have been first fully realised towards the end of the Post Office tests between Holyhead and Howth (concluded in May, 1902). Current practice at that time tended towards the use of heavy solid wire or metallic tapes in the construction of spirals for transmitting and the use of small gauges of solid copper conductors for the receiving coils. Owing to the well-known "skin-effect" resistance for high-frequency currents, the tendency was towards broad metallic ribbon in order to obtain considerable surface of metal and thereby reduce the resistance. The effect of magnetic leakage in the spirals had apparently been overlooked by other investigators. The effect of this leakage is virtually to place the mass of the conducting spiral in a high-frequency alternating magnetic field which cuts across the section or face of the conductor and generates eddy currents, or Foucault currents, to an extent depending on the ratio of length to diameter of the complete spiral and on the dimensions and disposition of the conductor. Though the losses from this cause may be small when the spirals are small, or of short length, and small-gauge conductors are used, they were shown to be by no means negligible when long copper-tape spirals traversed by heavy oscillating currents were used. The replacement of copper tape conductors by stranded copper-wire cables made up with separately-insulated small-gauge wires appreciably enhanced the efficiency of the transmitters used, whilst a similar replacement of single small gauge copper wires for winding receiving spirals by strand conductors of three or four separately insulated wires of smaller gauge produced a corresponding improvement at the receiver. The benefit derived from this stranding is still more marked where loosely coupled transmitters and receivers are concerned. Another source of loss, viz. that produced by brush discharges from the edges of the tinfoil coatings of high-tension condensers, was also attended to, the discharges being suppressed by dipping the condensers repeatedly in melted paraffin wax in such a way as to provide a substantial coating of wax over the edges of the conducting coverings. The alternative plan of immersing the condensers in a bath of oil also presented itself, but was not tried, except in the case of a special condenser with an all-oil dielectric, which did not prove successful by reason of dielectric troubles under the conditions of high-tension discharges necessary. For reducing the condenser losses due to imperfect adherence of the metallic coatings to the glass dielectric, or to the presence of a semi-conducting adhesive, the plan of coating by chemical deposition of silver was arranged for. The actual tests of these took place some time after the close of the Holyhead-Howth, but though more efficient electrically, no satisfactory method of arriving at a mechanically robust construction on this plan was arrived at, and, on the whole, the benefit to be derived appeared small in view of the unavoidable losses occurring in the spark-gap itself. It was evident, however, that the spark-gap losses were surprisingly small in view of the nature of the effects taking place in electric discharges through air.

TESTS OF LOOP AËRIAL SYSTEMS.—Among a number of methods investigated, one of the most interesting was that originally devised by Mr. Nevil Maskelyne, in which the aërial is formed by a loop conductor suspended from the mast and closed through a condenser on the one side and a spark-gap on the other, an earth connection being provided between them. The receiver was similarly arranged except that the Maskelyne "conjunctor" (a form of single-contact coherer) took the place of the spark-gap. The claims of the inventor regarding efficiency and directional qualities of this system rendered it desirable to investigate its properties. The investigation showed that the system as arranged by the inventor did not possess appreciable directive qualities of radiation over the range tested, and that it was not so effective as the syntonised elevated wire system with oscillation transformer for receiving, but modifications of the system, made with a view to testing it under syntonic conditions of working, led to the production of a distinctly effective method of loop transmission and reception. By including a condenser in one side of the loop for transmitting, as originally arranged, together with an inductance spiral and direct-coupled closed-circuit oscillation circuit in the other side, and earth connection between them, a transmitting method having distinctly better syntonic properties than the usual elevated wire transmitter was arrived at. Combining this with a loop aërial receiver, in which a Post Office oscillation transformer was inserted in one side of the loop and an adjustable condenser in the other, a syntonic system was evolved which was quite in advance of any syntonic method tried up to that time, and had somewhat greater range of response for equal power imparted to the transmitter. Though it was not fully appreciated at the time, this method undoubtedly owed its enhanced efficiency to reduced coupling inherent to the scheme of connections.

INSULATION OF STAYS TO MAST.—Tests made showed that for waves of the order of length used (viz. about 750 to 1200 feet) the division of the stays by insulating links and their insulation from earth had considerable effect both on transmission and reception. It was most noticeable, indeed, in its effects on the strength of received signals, the earthing of the stay wires producing a considerable drop in strength of signals.

Numerous other investigations of a minor character took place, and the stations were again used for tests, both by Sir Oliver Lodge's assistants and by Mr. Maskelyne, assisted by Mr. A. W. Sharman, during intervals of the Post Office investigations. In neither case, however, were the full results made known to the Post Office.

In 1905 the Howth station was once more made use of in Post Office tests, when Mr. W. Duddell and the writer conjointly carried out a series of observations for the purpose of measuring the strength of currents received from a temporary installation on the "Monarch." On this occasion full use of variable coupling methods was made. The results of these observations are embodied in a paper read befere the Institution of Electrical Engineers in May, 1905.

CONCLUSION.—In bringing to a close this account of the Post Office association with the early history and development of wireless telegraphy, and in order to remove any erroneous impression which may have been gathered as to departmental extravagance in the pursuit of the investigations so far as the British Post Office is concerned, it may be interesting to summarise briefly the amount of time of responsible officers actually spent in experimental work at temporary installations from 1896 to 1902:

1896.—Tests of Marconi's original apparatus in General Post Office Laboratory, on roofs of General Post Office and Savings Bank, and in practical tests on Salisbury Plain: one, and sometimes two, officers about two months.

1897.—Tests in Bristol Channel (Lavernock and Flatholm

Island): Two officers about two weeks. Tests at Dover (Fort Burgoyne): Two officers about two months.

1898.—*Nil.*

1899.—Tests in Bushey Park (Schaefer's system): One officer one week. Tests at Lavernock and Brean Down: Two officers about two months.

1900.—Tests at Ilfracombe and Swansea: One officer about three months.

1901.—Tests at Holyhead and Howth: Two officers about four months.

1902.—Tests at Holyhead and Howth: Two officers about three months.

The total time so expended is equivalent to one officer engaged for about thirty months in six years.

The designing, installing, and maintaining of radio-telegraph stations, together with the experimental aspect indissolubly connected with the work in its present stage of advancement, constitutes altogether one of the most fascinating problems of modern engineering. It affords a training which no true engineer will despise, covering, as it does, practically the whole ground of electrical engineering, from problems in power-plant (some of which present entirely novel aspects) to delicate laboratory methods; from electric currents of large magnitude to those perceptible only with the finest and most delicate appliances known; and from steady currents through the whole gamut of frequencies to those of the Hertzian order.

Speaking from an experience of close association with progress in wireless telegraphy extending over a period certainly not less than that of any other engineer engaged on the work, the writer feels that it cannot be truly said that such an experience is of a "narrowing" or "one line" character. The problems concerned are of an all-embracing kind, such as no other branch of engineering can claim.

A YEAR'S TELEPHONE PROGRESS IN LONDON.

In the review of telephone work in London during 1909, which appeared in this Journal a year ago, reference was made to the effect on telephone progress of the trade depression which existed during the whole of 1908 and in a modified degree during the earlier part of 1909. The number of cases where telephone installations were given up owing to bad business, bankruptcy, or other cause due to trade depression was, it is true, not so great as in 1908, which was a bad trade year throughout, but it was sufficiently great to demonstrate, when taken in conjunction with the figures showing the increases in circuits to the various London exchanges, how reliable an index to trade movement can be afforded by telephone figures.

The same truth is evident in telephone figures for 1910, the year which it is the purpose of the present article to review. Telephone progress, as will be shown subsequently, was satisfactory. Trade during the year was satisfactory. The figures showing how each of the post office exchanges in London has developed during the year are the best of recent years. The figures showing trade development during the year are on record-breaking lines.

It will be interesting, in this connection, to study the reports of some of the American telephone companies for the past year. Neither trade, nor financial, nor stock market conditions were good in the United States. While Great Britain was exporting and importing goods to the value of well over one thousand million pounds, Germany was increasing her internal and overseas traffic, and France was showing steady accumulation of wealth through thrift and industry, the United States was having one of its real bad times. It will be remembered that the telephone industry in the United States was considerably and prejudicially affected by the financial crisis of 1907, as shown by the published statistics of the Bell Companies.

The good trade conditions in Great Britain should be reflected in the telephone figures of its chief commercial centre. The following table shows the development during the year, the figures in connection with each exchange being compared with the corresponding figures for the preceding year.

Exchange.	Direct Lines.		Stations.	
	Number working on Dec. 31st, 1910.	Increase over 1909.	Number working on Dec. 31st, 1910.	Increase over 1909.
Barnet	277	65	808	74
Burgh Heath	78	78	85	85
Central	14605	decrease 10	24616	891
City	3036	1112	4956	2012
Central and City combined	17641	1102	29572	2903
Chiswick	968	89	1114	123
Croydon	767	82	846	94
Ealing	846	89	945	105
Epsom	234	35	261	44
Esher	129	18	140	21
Finchley	683	245	744	269
Hampstead	4209	536	4734	409

TELEPHONE PROGRESS IN LONDON.

Exchange.	Direct Lines.		Stations.	
	Number working on Dec. 31st, 1910.	Increase over 1909.	Number working on Dec. 31st, 1910.	Increase over 1909.
Harrow	328	39	393	53
Hornsey	1170	238	1281	259
Hounslow	161	18	186	20
Hyde	7	7	7	7
Kingston	1022	63	1211	83
Malden	102	29	108	31
Mayfair	4881	539	6931	982
Mitcham	64	8	81	10
Molesey	76	76	84	84
Official	223	14	334	15
Purley	232	179	248	192
Putney	1300	186	1453	166
Richmond	962	106	1111	125
Southall	40	5	61	20
Sutton	614	89	665	106
Treasury	164	8	244	19
Trunk	105	9	131	11
Victoria	3438	373	6974	978
Wembley	95	19	123	16
Western	5430	758	6714	1183
Willesden	831	303	897	335
Wimbledon	937	105	1049	122
Total	48014	5510	69035	8944

It will be seen that the total increase in the number of stations over 1909 was nearly 9000. As will be seen from the following table, this is the largest yearly increase since the commencement of Post Office telephone enterprise in London.

1902	6294	1st year
1903	8007	Increase over 1902
1904	7880	" " 1903
1905	8738	" " 1904
1906	7564	" " 1905
1907	7872	" " 1906
1908	6067	" " 1907
1909	7669	" " 1908
1910	8944	" " 1909
	69035	

The imminence of the transfer of the National Telephone Company's system to the Post Office was possibly responsible for part of the increase. It is conceivable that some new subscribers in districts served by the Post Office and the Company would turn to the Post Office rather than to the Company, arguing that by so doing they would not be subjected to a change of number when the transfer took place. It is conceivable, too, that some old subscribers with lines from both Post Office and Company would be inclined to go to the former rather than to the latter for any additional requirements. The British public does not, however, as a rule, look so far ahead, and it is more than likely that the great majority of the applicants for circuits did not think anything about the transfer at all. This view is confirmed by the fact that it is only since the Department took, quite recently, active steps to inform subscribers to certain National exchanges that something was going to happen at the end of 1911 which would affect them as telephone subscribers that inquiries from such subscribers as to their position under a Post Office *régime* have been received. Even these inquiries have been comparatively few, although they are showing a tendency to increase, and it is perhaps to be expected that during the last half year of the Company's existence a considerable amount of interest on the part of their subscribers on questions relating to exchange numbers, rates, etc., will be displayed.

The approaching demise of the Company having little or nothing to do with the record increase of the Post Office London system, there remains the fact of the trade activity. The effect of this activity on telephone progress is shown further on in another way by the figures showing cessations of installations through bankruptcies and other causes.

The figures of individual exchanges indicate rapid progression on the part of the exchanges serving commercial districts. Central and City, which serve the City neighbourhood, show a combined increase of close upon 3000 stations. This is the best the Department has done in the City since 1905, when over 3600 stations were joined up. Mayfair shows an increase of nearly 1000 stations, also the best since 1905, and Western an increase of 1183, which is a record increase for the exchange. The Victoria increase of 978 is slightly less than that of 1909, and might be regarded, because of that fact, as disappointing were it not for the fact that the abnormal increase of stations to this exchange in 1909 was due to appreciation on the part of certain large Government offices in the Victoria area of the benefits of more direct telephone communication with the public system than they had had previously. But for this last year's increase would have been greater than that of 1909.

All the suburban exchanges show substantial increases over the 1909 totals, and most of them show larger increases than the 1909 increases. The best result relatively is that of Purley, which would have furnished a still better figure had progress in the district not been hampered by wayleave and other difficulties. With the completion of the proposed new exchange in Brighton Road and an improvement in the relations between the Department and the local council with regard to wayleave differences, the Purley Exchange will develop still more rapidly.

The total number of cessations last year was 2757. This number is slightly greater than that of the previous year, with which, however, it compares favourably when the percentage of cessations to stations is taken. The subjoined table gives an analysis of the causes for cessation and a comparison with 1908 and 1909.

Year.	Deaths.	Bankruptcies.	Giving up business.	Removed, unknown.	Business bad.	Leaving area.	Miscellaneous.	Total.
1910	84	107	157	247	836	877	349	2757
1909	105	115	170	395	896	572	470	2723
1908	68	226	188	576	788	308	450	2544

Percentage of Cessations to Stations.

1910	3·9
1909	4·5
1908	4·8

It will be seen that the cessations through bankruptcy, surrender of business, and bad business, were less than in 1909.

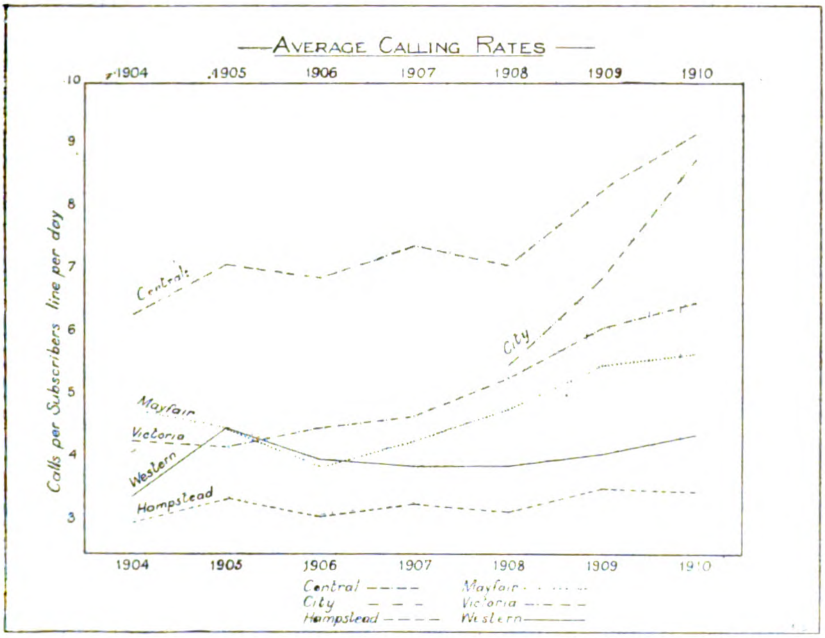
The total number of removals carried out by the Department last year was 6226. With an increasing number of subscribers the number of removals increases year by year, but the percentage of removals to stations remains, as will be seen from the following table, fairly constant :

	Stations.	Removals.	Percentage of removals to stations.
1905	30,919	2851	8·35
1906	38,483	3372	8·76
1907	46,355	4036	8·61
1908	52,422	4395	8·38
1909	60,091	5458	9·08
1910	69,035	6226	9·01

There was again a marked increase in the number of calls made by subscribers. Nothing is more striking among telephone statistics than the figures showing the growth of the telephone habit. Every year the rate of calling per subscriber shows an appreciable increase, and last year the increase was very marked indeed. The following table shows the growth of the telephone habit among subscribers to the six largest exchanges in the London area. The figures are from records taken in November, and they are compared with the figures from records of November, 1909, and November, 1908.

	Average number of calls per line per day.		
	1908.	1909.	1910.
Central	7·2	8·6	9·4
City	5·5	7·2	8·8
Hampstead	3·2	3·5	3·8
Mayfair	4·8	5·5	6·0
Victoria	5·3	6·2	6·6
Western	3·3	4·3	4·8

The following diagram shows graphically the increase in the calling rate per subscriber per day for the six exchanges mentioned,



CALLING RATES OF LONDON POST OFFICE EXCHANGES.

the average rate for the whole of each year from 1904 to 1910 being taken. Observe the pronounced drop in 1906, a bad trade year in the cases of the Central, Hampstead, Mayfair, and Western Exchanges.

The effect of this increase in calling rates will be seen more clearly by taking the case of the Central Exchange. Central is a good exchange to take because it was nearly full at the end of 1908, so that the situation is in no way complicated through increase in the number of subscribers. The table shows that each subscriber makes 2·2 calls per day more than he did in 1908. With 14,000 subscribers—the Central number—the total number of additional calls per day through the increased user amounts to 31,000 calls, which, after allowing for corresponding increase in incoming traffic represents additional staff, including the appropriate supervising force, to the extent of close upon eighty operators. When it is considered that the same movement is taking place at every other exchange in London some idea of the enormous amount of additional work thrown on the exchanges and of the consequent staff and accommodation problems is obtained.

The total traffic dealt with at the large exchanges is shown in the following table. It gives the number of incoming and outgoing calls during a day in November last, and a comparison with the figures for a day in November, 1909, and a day in November, 1908.

	Calls dealt with in one day.		
	1908.	1909.	1910.
Central	253,320	304,155	330,421
City	15,434	27,710	51,531
Hampstead	28,218	31,404	33,724
Mayfair	37,550	45,482	56,734
Victoria	30,183	38,696	46,412
Western	31,709	29,760	47,835

It will be seen that the traffic each day at these six exchanges alone amounted to over 560,000 calls, or, allowing for holidays and Sundays, at the rate of 168,000,000 calls in a year. In the face of a figure such as that, the writer, who never feels on secure ground after entering the millions, trembles to think of the figures he may have to quote in subsequent reviews when the National Telephone Company, whose system in London of over 130,000 stations is not much less than double the size of the Post Office system.

It has not been possible in this short article to do more than touch on one or two of the more outstanding features of the purely traffic side of the subject. It is hoped to deal more fully with this phase in a further article.

THE USE OF DIELECTRICS, AND THE PRINCIPAL TESTS APPLIED TO THEM.

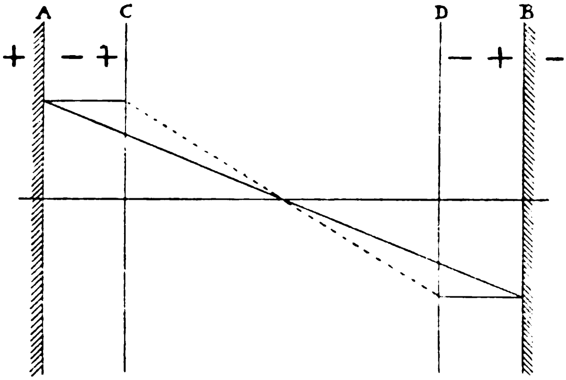
By Thomas Germann
(Bronze Medallist), Survey Section E. in C.O.; and

Stanley M. Hills
(Bronze Medallist).

Abstract, by special permission, of paper read before the Junior Institution of Engineers.

A substance insulates by virtue of three distinct properties; first, the ability to stand mechanical and electrical stresses due to the voltage used; secondly, conductivity such that but a negligibly small current can flow through it and leak away; and thirdly, the power to resist any chemical action that may be caused by the application of the voltage. There is no direct relation between the breakdown E.M.F. and the ohmic resistance of an insulator. A low ohmic resistance usually means a low breakdown test, but a low breakdown test does not necessarily mean a low ohmic resistance. The principal value of ohmic resistance measurements is the proof they afford of damp-proof properties.

REQUIREMENTS OF AN INSULATOR.—A good insulator should possess the following qualities: (1) High disruptive strength; (2) good insulation resistance; (3) physical properties permanent over a wide variation of temperature; non-volatile; (4) non-hygroscopic; (5) able to resist the action of water, acids, alkalies and oils; (6) fireproof.



I.—R. A. FESSENDEN'S EXPERIMENT.

As no single substance fulfils all requirements, in order to obtain a satisfactory insulator "mixtures" are resorted to. An insulator will thus consist of pure rubber, vulcanised rubber, impregnated paper and cotton, varnish, oil, and air.

FESSENDEN'S, SYMONS', AND BAUR'S EXPERIMENTS.—A mixture causes an unequal distribution of pressure in the dielectric, and this will probably account for a large number of insulation troubles. In 1898 Mr. R. A. Fessenden performed the classical experiment which illustrates this point. He took two plates, A and B, 1 cm. apart with an alternating current between them of 10,000 volts. He then introduced two plates of glass, C and D, with specific inductive capacity of 8, each plate being ¼ cm. thick (the voltage divides itself inversely to the capacities), and had 8890 volts between C and D, so that the potential gradient in the air was 17,800 volts per cm. instead of 10,000 volts. The air only supports 15,000 volts, so instead of a safety factor of 50 per cent. a spark passed between C and D at every reversal of the voltage. This rapidly heated the glass and caused it to conduct the full potential of 10,000 volts passing between C and D, resulting in the formation of an arc.

From this experiment it is seen that the introduction of a better insulator between the plates has the effect of weakening the insulation. This result will always be obtained with alternating currents, unless the whole space is filled with the same material, or matters so arranged that each layer has the same capacity, *i.e.* the electric displacement in each part must be the same.

Another experiment which illustrates a form of trouble was that made by Mr. H. D. Symons, who found that if tinfoil circles were pasted on both sides of a test sample of gutta-percha and used as contacts, the breakdown voltage was less than when a sample of the same thickness was tested between two parallel circular plates of the same diameter.

Dr. Baur made several experiments to determine the relation between the breakdown voltage and the dielectric strength of an insulator, and he found that this relation could be expressed by the equation:

$$V = c\,d^{2/3}$$

where d = thickness of insulation in millimetres,
V = potential difference in R.M.S. volts A.C.
c = a constant representing the potential difference necessary to breakdown a sample of the dielectric 1 mm. thick. This constant is termed "the electrical breaking-strength."

The values for the electrical breakdown strength are given in the following table:

VALUES FOR "ELECTRICAL BREAKING STRENGTH."

Dielectric.	"*c*"
Empire cloth	12,500 volts.
Fuller board	19,000 ,,
Mica	58,000 ,,
Dry air	3,300 ,,

The wave-form of the testing voltage considerably affects the dielectric strength, as a saw-tooth E.M.F. wave will break down insulation of all kinds more readily than a flat and smooth wave of the same square root of mean square electro-motive force (R.M.S. voltage).

For insulators, glass or porcelain gives excellent results up to about 5000 volts, but most of those of glass permit of surface leakage, even when new, and they weather very considerably. In time the surface becomes somewhat roughened, and then dirt and moisture begin to collect until a conductor is formed which is fairly good. Again, glass is slightly soluble in water, and this in itself is a reason for its hygroscopic nature. It should never be used in damp climates. Variations of insulating efficiency occur; a drizzling rain or a fog will be found to result in effects more detrimental than those due to a heavy rain. The latter tends to wash off any dirt from the outer surfaces, and has practically no effect upon the undersides of the petticoats.

In regard to porcelain, it is found that cheap material is often extremely hygroscopic; especially is this the case with some of the American porcelain, which will absorb 1 to 2 per cent. of its weight of water, thus showing poor insulating properties. The best porcelain should absorb no moisture, and should show a brilliant vitreous fracture which will give no flowing stain on the application of ink. The glaze on the porcelain affects the properties. Glass is homogeneous throughout its thickness, but with porcelain it is a common experience to find that as soon as the glaze is damaged a porous and practically uninsulating porcelain is revealed. Thoroughly vitrified porcelain, in which the ordinary glaze is replaced by an actual fusing of the material itself, is much preferable to ordinary glass. It is strong and tough, non-hygroscopic, has very high insulating properties, the surface does not weather, and the insulation is practically permanent. If the vitrification extends considerably below the surface the resistance will not only withstand leakage, but puncture, better than any glass.

Oil.—The use of oils has considerably increased with the introduction and increase in popularity of high-tension generation and distribution, for use for transformers, switches, and the like. The following is the specification proposed by Mr. Skinner in a paper read before the American Institution of Electrical Engineers.

I.—The oil should be a pure mineral oil obtained by fractional distillation of petroleum, and unmixed with any other substances and without subsequent chemical treatment. II.—The flash test of the oil should not be less than 180° C., and burning test not less than 200° C. III.—The oil should not show an evaporation of more than 2 per cent. when heated at 100° C. for eight hours. IV.—The oil must not contain moisture, acid, alkali, or sulphur compounds. V.—It is desirable that the oil be as fluid as possible, and that the colour be as light as can be obtained in a pure untreated oil.

There are two principal methods of testing the breakdown voltage of the oil, namely: (1) Between two spheres submerged in the oil and placed half an inch apart. (2) Between two needle points submerged in the oil and placed half an inch apart. The results obtained by the latter method are lower than those obtained by the former, and since in a transformer or switch there are many sharp edges, if not points, the authors favour the use of the needle-point method. The distance the needle points are submerged in the oil depends upon the strength of the oil, as "arcing over" must not take place.

Whilst the voltage is being increased, all the particles of dirt, etc., present in the oil collect between the two needle points. If the voltage is switched off, these particles can be removed on a piece of blotting paper and should be examined microscopically, when metallic particles can be distinguished. The presence of moisture is the greatest evil, as the presence of 0·05 per cent. moisture will reduce the dielectric strength to one half.

VARNISHES.—Varnishes are chiefly manufactured from linseed oil, and this fact is often plainly stated in manufacturers' price lists. Up to quite recently linseed oil was a very undesirable ingredient in an insulating varnish, as it rapidly absorbed oxygen and formed a tough elastic oxide; this oxidation may continue until a viscid substance partially soluble in water is formed.

Samples immersed in water at a temperature of 60° F., for twenty-four hours showed the following results:

Specimen (a), almost entirely linseed oil, 2·15 per cent. absorption of moisture.

Specimen (b), 15 per cent. linseed oil, 0·85 per cent. absorption of moisture.

Specimen (c), no linseed oil, 0·15 per cent. absorption of moisture.

That the effect of this absorption on the dielectric strength is very great is shown by the following figures:

Average breakdown voltage of linseed oil varnish, 517 volts;

Varnish free from linseed oil, not punctured at 933 volts.

It is common practice to impregnate cotton and cambric with insulating varnishes. Cotton contains acid bodies derived from Pectin, which are soluble in water, and although water is only feebly ionised on the application of an electric current it helps other substances to ionise, and in so doing sets up electrolysis and chemical action. The production of green on the insulation of copper conductors is commonly termed verdigris, but this is a mistake, for the green formation is a compound resulting from the chemical action produced by acids in the cotton acting upon the linseed oil.

Three preliminary tests on the physical properties have to be made before the electrical properties are tested. The sample of the varnish must be distilled, and the following tests then performed: (1) Flash-point in air (if any); (2) flash-point as given by one of the many pieces of flash-point apparatus now on the market; (3) place a small sample of the distillate on a watch-glass and evaporate to dryness. No residue should be left. This test should be carried out under a dust-proof cover.

The electrical tests are two in number, and show (1) the relation between dielectric strength and specific gravity; (2) the relation between dielectric strength and the time of application of the voltaic stress.

For the specific gravity test various samples of the varnish must be mixed with a suitable thinning medium, so as to obtain various samples of the varnish of known specific gravity. Suitable pieces of insulating paper must be dipped in these samples and the papers hung up to dry in an atmosphere of 70° C. for eight hours. When dry, they must be tested for dielectric strength by the parallel plate or slot method.

For the time test several pieces of paper are treated as in the specific gravity test, but the varnish is used at that gravity which was decided was the best from the results given by the specific gravity test. The paper is tested by the parallel plate or slot method, but instead of the breakdown voltage being desired it is the relation between the time of application of test and the voltaic stress applied which has to be obtained. This is done by connecting an electric bell in the circuit. When the sample punctures the bell rings, the time which elapses between the moment the voltaic stress is applied and the moment the bell rings being measured by means of a stop-watch. This test is made at various voltaic stresses, and an application of ten minutes is usually a long enough period, as at this point the curve runs into a straight line parallel to the abscissæ.

It is advisable to make the following supplementary tests: (1) Dip two pieces of copper strip in the varnish and dry for four hours at 70° C. Boil one of these samples in oil and one in water for a period of six hours. No signs of blistering should be visible if the varnish is suitable for withstanding the action of heat. A sample of varnish which is to be used in an oil-cooled transformer should always be tested in this manner. (2) Cut some of the dipped paper up into strips ½ in. wide, and test it for brittleness by bending a strip round pieces of iron rod. These rods should descend in diameters from 1 in. to $\frac{1}{16}$ in. in stages of $\frac{1}{16}$ in. A good varnish will bend round the smallest rod without cracking. (3) It is often found that when cambric or linen is treated with an insulating varnish its tensile strength diminishes. If the varnish is to be used in making tapes for insulating coils the tensile strength is an important property, as a tape which will not bear a tensile strain is useless. A piece of cambric should be dipped in the varnish, dried for four hours, and then tested. (4) Dip a piece of copper strip in the varnish and heat at 70° C. for four hours. Heat the sample over a Bunsen flame and note the temperature at which the varnish becomes soft and tacky. The latter point should not be less than 80° C.

Insulation often rapidly deteriorates with age, and it is necessary to store samples of insulation and test them after they have been stored about three months.

Since insulation is a bad conductor of electricity, in most cases it is a bad conductor of heat, and this accounts for its deterioration with age. There are, however, insulating materials on the market which do radiate heat, a notable example being electro-enamel, a mixture introduced by Mr. Turner. These substances, however, being expensive and usually in the form of a paint, are not suitable for impregnating papers, cambric, etc. The heat-radiating property of the insulation considerably affects its conductive power: the greater the temperature, the greater the conduction of electricity.

LINEN, ETC.—Linen and cambric play important parts in insulating, it being usual to impregnate these with varnish, and a few tests may be mentioned to which they should be subjected. The first is to cut the linen up into strips half an inch wide, and test both in the direction of warp and weft for tensile breaking stress and elongation. The following table shows the average figures obtained:

	Average elongation.	Breakdown stress.
Linen and cambric . .	8–10 per cent.	90–120 lb.
Brown linen . . .	3–5 „	80–100 „

The texture should be fairly fine, but not so fine that varnish cannot percolate and soak into the pores of the material. Dressing is a disadvantage, and should be avoided as much as possible, as it is liable to contain chlorine from the bleaching operation, and the chlorine will react on the varnish and cause rotting. The best test for chlorine is to boil a sample of the cambric in water and add a few drops of silver nitrate, when chlorine, in the guise of a chloride, will be indicated by a white precipitate. The softness of the material increases inversely with the dressing.

If the linen or cambric is to be used for the production of oiled linen, such as Empire cloth, it should be closely woven, as oil will not satisfactorily fill large pores or openings in the cloth. These oiled cloths possess a high dielectric strength, are very flexible when new, but rapidly deteriorate with age, and it is imperative that "ageing tests" be made on this class of insulator.

MARBLES, ETC.—The following are the tests which should be applied to these materials:

(1) For the determination of moisture weigh a small sample of the marble and roast in an ash furnace for three hours. Weigh again, and the difference in weight gives the moisture present, and should be expressed as a percentage of the original weight. The percentage of moisture should not exceed 0·5 per cent.

(2) To ascertain the absorption of moisture, weigh a sample of the marble, immerse it in water for twenty-four hours, and weigh again. The gain in weight gives the quantity of water absorbed and should be expressed as a percentage and should not exceed 0·5 per cent.

(3) For crushing stress a sample of the marble should be tested in a mechanical crushing machine and the result expressed in tons per square inch.

(4) Workability is usually determined by drilling a hole in the sample and noting the time taken to drill ½ inch deep, and the temperature of the tool after the experiment.

(5) To arrive at the dielectric strength, a sample of the stone should be placed between two parallel brass plates and a voltaic stress applied. The voltage at which the moisture commences to evolve in the form of steam, and also the voltage at breakdown should be noted.

Though marble is preferable to slate on account of its greater freedom from metallic veins and more pleasing appearance, it is by no means an ideal switchboard material. It is one of that class of substance which is always cold, consequently it rapidly condenses moisture, and this on a switchboard causes surface leakage.

Marble used in electrical machinery is usually of a soft variety, and will crack with a knock or jar, and if a panel of a switchboard cracks great inconvenience may be caused. Hard marbles can be used, but a great sacrifice in dielectric strengh has to be made. The authors have found by experiment that:

(1) Mechanical properties of marble are good in the inverse proportion to the electrical properties.

(2) The greater the specific gravity the lower the absorption of moisture.

(3) The greater the specific gravity the lower the breakdown voltage.

(4) The greater the specific gravity the greater the crushing stress.

It will thus be seen that the specific gravity exerts considerable influence on the electrical properties.

DYNAMO INSULATORS.—A number of composite insulations are used, consisting of mica strip pasted on to sheets of another insulating material, amongst which the following may be mentioned:

(1) Two sheets of red rope paper with one thickness of mica between them, the whole being shellaced together. The average B.D.V. is about 230 volts per mil.

(2) Mica and bond paper made in a similar way. Average B.D.V. 250 volts per mil.

(3) Mica and canvas. B.D.V. 65 volts per mil.

The B.D.V. above are R.M.S. values, and the main insulation is due to the mica, the outside covering being determined by the allowable space factor and the mechanical strains which have to be met.

It is common practice to insulate armature coils and field coils by taping them with cotton tape wound on the half lap. The coil is then dipped in an insulating varnish and afterwards baked in an oven. The object of the dipping is to thoroughly impregnate the tape with a good insulating material, at the same time excluding any moisture. Permanently good results cannot be obtained if there is any moisture in the coils, not only because moisture is occupying the space which should be occupied by the varnish, but also because when continually undergoing temperature changes, which occur in the case of a dynamo, disintegration is set up in the mineral and vegetable fibres of the cotton ; this in the course of time may utterly break down the insulation. From this it will be seen that the very first procedure is to exclude any moisture, and this may be done by heating the coils *in vacuo*, and while the coils are still hot forcing the varnish into them under pressure.

Where this process cannot be carried out it is usual to heat the coils in a well-ventilated oven immediately after taping, at a temperature of 90° C. for about three to four hours, until all moisture is excluded. All products of combustion should be excluded from the oven, as water vapour is always in suspension in the products of combustion of gas, wood, or coal. When the coils are thoroughly hot they are ready for the dipping process. The varnish is poured into tanks, and the coils are immersed and allowed to remain until air-bubbles cease rising to the surface ; the varnish thus fills every space and in so doing forces the air out. The coils are then removed from the tank and held over it, so that all surplus varnish may drain off. It is advisable while draining to occasionally turn the coils end for end, so that a fairly uniform coating is obtained. The coils are then ready for baking, which should continue until the varnish is plastic at a temperature of 90° C.

After baking, it is the usual practice to bind the coils with some suitably strong tape, after which the whole is dipped again in the varnish. The coil now need not be hot ; as a matter of fact a cold dip gives a thicker coating and a better finish than a hot dip. The coil is now drained as before. If, however, the desired coating is not obtained, then after about half an hour's draining the coil is given a quick dip in and out again, and re-drained. It is now ready for the final baking.

The temperature, as before, should be about 90° C., cotton, silk, or other fibrous insulation not being injured, even up to 105° C. Baking at a lower temperature incurs loss of time in the operation, and is liable to introduce the risk of moisture, while if a high temperature be used the permanent elasticity of the varnish is injured, and it is liable to break or chip. After baking the coils are ready for use.

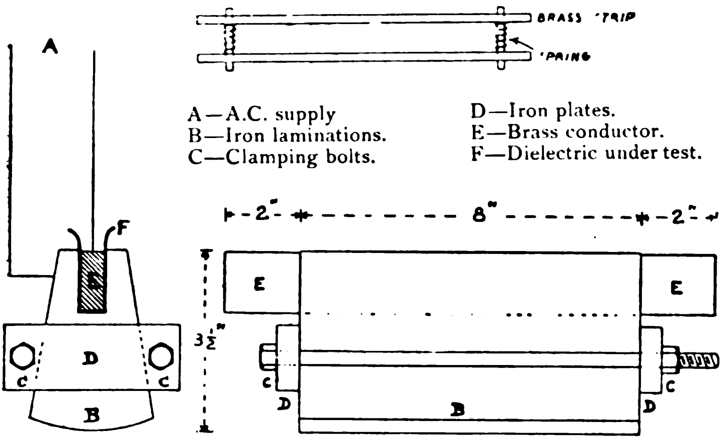
It is usual to line the armature slot with some fibrous material, suitably treated, to render it waterproof, and then to place the former wound coil in the lined slot. All slot lining material should be thoroughly dried and waterproofed, the best method being to submit the material to prolonged soaking in hot linseed oil. It should be noted that most papers have a grain, and where used for slot linings or for purposes where the paper has to be bent, that the paper should be bent along the grain.

THE "SLOT" METHOD OF TESTING.—This is a new method of testing dielectrics which are to be used in the insulation of armature coils. The method carried out by the authors consists essentially in testing a sample of the dielectric in a laminated iron slot, a sketch of the apparatus being shown in the figure. The conductor used was of such a size as to exert a fairly light but uniform pressure on the dielectric when the dielectric was placed between the conductor and the laminations. Various sized conductors were used in order to test dielectrics of differing thicknesses, the size of the conductor being larger or smaller than the first conductor which was used in direct proportion to the thickness of the dielectric; thus the pressure on the dielectric was always the same.

Before being tested, all the samples were dried at a temperature of 70° C. for a period of four hours, and were then stored in a box containing calcium chloride (which is a drying agent), and used as required. Mr. Hobart's figure of 60° C. for the temperature of a dynamo was taken, and all samples were tested in an atmosphere of this temperature. A very accurate Brown and Sharpe micrometer, with ratchet attachment, was used for measuring the thickness of the sample at the point of fracture.

The authors recommend the use of a conductor, as shown in the figure, which consists essentially of two brass strips kept apart by two spiral springs. In this arrangement the pressure on various dielectrics of different thickness is not the same, and practically only the sides of the slot are used, the bottom not being fully occupied, but considering the fact that springs are employed in the parallel plate method, and since the variation of pressure will not vary much with normal variations of thickness of dielectric, it may be said that the disadvantage is outweighed by the resultant increase in convenience. All experiments were made with solid brass conductors.

In order to compare the results obtained, a number of tests on dielectrics were made by both methods under precisely similar conditions with regard to temperature, etc.



End view. Side view.

2.—APPARATUS USED BY THE AUTHORS.

It was expected that there would be considerable difference between the results of the open slot system and the parallel plates. This expectation was realised, as is shown in the following table:

Dielectric.	B.D.V. per mil. in open slot. A.	B.D.V. per mil. between parallel plates. B.	Percentage difference. $(100 - \frac{A}{B} \times 100)$
B.P. black paper	133	166	19·3
Japanese rice paper	88·5	222	59·5
Parchmentised paper, treated with linseed oil	809	980	17·5

The relation between dielectric strength and thickness does not follow a straight line law, but as the slope of the curves of the various dielectrics tested was about the same and not much different from a straight line, and also because many manufacturing firms use it, the author adopted the term "B.D.V. per mil" as a convenient standard of comparison. The voltaic stress was obtained from a 50-period alternating current circuit, and no results were registered, when on removing the insulation from the slot it was found that the dielectric had been damaged by contact with the laminations.

It is imperative that great care should be taken to make tests which are to be used for comparative purposes under precisely similar conditions. Tests are often conducted in a very slovenly manner, the thickness of the dielectric being measured with micrometers without ratchet adjustments. With such instruments the personal equation becomes a very important factor.

The authors' tests were made at a temperature of 60° C., but their experience leads them to consider that where speed is of importance it is far better to test at the atmospheric temperature, as it is very difficult to maintain a uniform temperature during testing.

AMPÈRE.

By AND. FRASER.

> " As to my son, there is nothing that I do not expect from him. . . ."

THESE words were written by the father of Ampère a few hours before ascending the steps of the scaffold on which he was to lose his head for having opposed the excesses of the revolutionary movement of his time. We shall see, as our brief biography unfolds itself, whether the expectations of the father were realised in the son.

André-Marie Ampère was born at Lyons in the year 1775, and it is recorded that, whilst yet in his infancy, he worked out long arithmetical sums by the aid of pebbles and biscuit-crumbs before he even knew the figures. Observing the child's genius for mathematics his father left off teaching him Latin, but the boy soon returned to it in order that he might be enabled to understand the works of Euler and Bernouilli. At the age of eighteen Ampère had read through the whole of the 'Encyclopèdie' to such purpose that fifty years afterwards he could repeat entire passages from memory.

The death of his father threw Ampère into a state of idiocy, a state in which he remained until there fell into his hands a copy of Rousseau's letters on " Botany." This had the effect of dispelling his apathy and re-awakening the passion for knowledge. At the age of twenty he was conversant with the whole realm of mathematics and geometry, a Greek and Latin scholar, a writer of poetry and tragedies, of rhymes and madrigals, and a student of chemistry, physics, mechanics, heraldry, and philosophy. There was nothing that he did not know.

In winter he rose at four in the morning, joined a band of enthusiasts like himself, and studied the writings of Lavoisier, marvelling at those things in it which he, ignorant of his own potentialities, was later to equal if not to surpass. But amidst it all Ampère felt a void in his heart which his studies could not fill, and he complains that "the cry of Nature spread a vague and insupportable disquietude throughout my soul," and proceeds, "One day when I was walking after sunset by the side of a solitary rivulet. . . ." These words are all that the sheet on which they are written contains, but they serve as the prelude to a journal which, from this time, he kept. They herald the coming into his life of the woman who is ultimately to become his wife. On the first page of the manuscript, the original of which is covered with x's and y's, is the word "Amorum"—the last word of a title, the beginning of which has been torn off. A copy of this 'Amorum' lies before the writer now. The first entry bears the date 1796, and reads thus:

André-Marie Ampère, 1775-1836.

> "Sunday, April 10.—I saw her for the first time."

Then follow in rapid succession entries relating directly or indirectly to Julie, and in which her most trivial actions are recorded. Under the date November 13th he records having mentioned to her a course of lectures which he proposes to give, and appends her significant comment, "If I could but see that *that* would lead you to anything." Ampère is poor, and has no possessions apart from the encyclopædic knowledge in his brain. This, it appears, is the obstacle to their marriage, and it is amusing for us to-day to read in his journal of the meeting which took place one evening between Ampère, Julie, and her mother to decide as to the most lucrative position he might secure. Both mother and daughter decided in favour of his becoming a bill-broker!

On August 6th, 1799, Ampère and Julie Carron were married, and in the following year their only child was born. But alas! from this time onwards his wife was stricken down with an incurable malady, to which she succumbed four years later.

We omit with great reluctance the letters which passed between Ampère and his wife during these few years—letters full of solicitude and tenderness for his ailing wife—letters in which the hopes and fears, the aspirations and disappointments of the man are set forth with a child-like simplicity that goes straight to the heart of the reader. We confine ourselves to some extracts.

Napoleon had offered a prize of 60,000 francs to anyone who, by his experiments and discoveries, should advance the science of electricity in the same measure as it had been advanced by Franklin and Volta. Ampère, writing to his wife, says:

> "I shall try and gain this prize, and if M. Delalande appoints me to the Lyceum at Lyons I shall be very happy, for you will want for nothing."

And again:

> "I have made a new discovery this morning, superior to those I have made hitherto—Oh, yes! far above them; if it were to lead me to the end that I expect my name would be immortalised."

In answer to one of his letters Mme. Ampère writes thus:

> "I see myself living peaceably with you both—with my two sons" [she playfully refers to Ampère in her letters as 'mon fils'], "as I regard you both, for suffering has made me old, and left me leisure to indulge reflections which have matured my reason. Thus, though our ages are so similar, you must fancy that your wife is ten years older than you are. This may be taken in every sense, for freshness, activity, gaiety, all the grace of youth have disappeared; my heart is the same, it will love you always; and that is enough for you, is it not, my good André?"

But we must leave Ampère the lover and husband, and turn to Ampère the scientist and mathematician.

In 1801 he was appointed Professor of Chemistry and Physics at Bourg, where he remained until his appointment to the Chair of Mathematics at Lyons in 1804. At this time he solved a problem which had baffled Buffon and Pascal, and showed that the chances at "*le jeu*" were, in the long run, against the gambler. In 1820 he heard for the first time of Oersted's discovery of the deflection of a magnetic needle by a voltaic current, and seven days later he read a paper before the Academy in which he showed that magnetic effects could be produced by electric currents alone, and that wires conveying currents were mutually attracted or repelled according as their currents were in the same or in opposite directions.

Then followed his brilliant theory of magnetism, which regards every molecule of a magnet as the seat of a closed electric current, and asserts that magnetisation takes place in proportion to the extent to which these currents are caused to flow in the same direction. In a word, he swept all magnetic phenomena within the realm of electro-dynamics.

In the year 1821 Ampère, at the Academy of Science, proposed *the first practicable electro-magnetic telegraph* in these remarkable words: "As many magnetic needles as there are letters of the alphabet, placed in motion by conductors made to communicate in order with the battery by the help of some mechanism regulated at will, would produce a telegraphic correspondence able to surmount all distance, and would be far more rapid than speech in transmitting ideas."

He established the law connecting the magnetic field produced at any point, with the current producing it, and of this law Professor J. J. Thomson has said, "The best proof of the truth of Ampère's law is that, though its consequences are being daily compared with the results of experiments, no discrepancy has ever been detected."

In 1809 Ampère was appointed Professor of Analysis at the Polytechnic School, Paris, and Professor of Physics at the College de France in 1824. Honours and distinctions came to him from all parts, and at the time of his death, in 1836, he was a member of the Institute of France, Fellow of the Royal Societies of London and Edinburgh, member of the Academies of Berlin, Stockholm, Brussels, and Lisbon, and of the learned societies of Cambridge and Geneva.

And now, as we bring our brief biography to a close, we ask the question: Did the son fulfil the expectations of his father when he wrote: "As to my son, there is nothing that I do not expect from him?"

Let the translator of the 'Amorum' answer:

"Prophetic words! Sacredly treasured up by him who was one day to justify them; many a time, without a doubt, ye have raised his courage on that rugged path that led him to glory!"

THE POST OFFICE AND ENGINEERING.

(*From a Correspondent.*)

(*Reprinted from 'The Times Engineering Supplement,' February 1st,* 1911.)

COMMENTING in a recent speech upon the growing importance of engineering in the work of the Post Office, the Postmaster-General laid particular stress on the fact that the Post Office had long ceased to be a mere carrier of letters, and is becoming more and more concerned with enterprises which call for the employment of the engineer. This, of course, is true not only of the Postal Department of the State —it is the case in almost every other branch of the public service. At the Admiralty the Engineering Department is of the first importance, being vitally concerned not only with ship design and equipment, but with the engineering works connected with the provision of additional dock and harbour accommodation. In the Navy the important place occupied by the engineer is coming to be recognised, and steps have been taken to raise the *status* of this branch of the Service. In the Army, also, the part played by the engineer is becoming a large one, and he is intimately concerned with the new developments in respect to motor transport and aviation, quite apart from the military matters which have for long claimed his attention. An international body, such as Lloyd's Register of Shipping, has recognised the work of the engineer by appointing representatives of the engineering and ship-building industries upon its governing body. Railway boards have, in several instances, selected an engineer for their first officer. There is thus revealed a gradually broadening tendency towards the appreciation of the engineer and the part he fills in modern life.

THE NEED FOR REFORM.

In none of these departments of public life, however, is the work of the engineer of more value than in the Post Office, and it is in this branch of the Service that less recognition has been accorded to the engineer than in any other. These facts were probably in the mind of Mr. Samuel when he delivered the speech to which reference is made above, and a review of the position will show that there is a clear case for reform. That the position of the Engineering Staff of the Post Office is the subject of real dissatisfaction among members of that staff is a matter of common knowledge. The causes of that dissatisfaction are not far to seek. Broadly, they are to be found in the fact that the administration of the Post Office has remained unchanged since the days when it was a mere carrier of letters. The Secretary of the Post Office is still the supreme head of all departments, and the chiefs of other departments can approach the Postmaster-General only through him. Nominally, the Secretariat controls the Engineering Department; actually, its members lack the requisite training to exercise any effective control. With the gradual rise of the engineering work of the Post Office to a position of supreme importance this nominal control must grow less and less effective. It is felt to be full time that the present system be recognised as an anachronism and a Post Office Board created, upon which the heads of all departments should have a seat, while being absolutely responsible for the work of their own section, and enjoying the power of direct communication with the Postmaster-General. America is ahead of us in postal administration; and following a system which has worked well in the United States, such a board as is here suggested might have upon it representatives of finance, engineering, telephones and telegraphs on both commercial and traffic sides, home and foreign mails, architecture, and factories. There can be little doubt that such a system of management would be followed by reforms, and would make for efficiency and economy of administration. Reference may be made to the present factory system as an example. These factories, which are mainly concerned with engineering requirements, are at the present time engaged in manufacturing processes on a large scale. Investigation would probably show the advisability of giving up the manufacturing part of the business, which could be better undertaken in open competition by private enterprise, and concentrating the energies of the Post Office factories on repairs and renewals. This is referred to merely as a single example of the reform which might follow proper subdivision of control.

THE IMPORTANCE OF THE ENGINEER.

It is not a difficult matter to establish a case for the wider recognition of the work done by the Engineering Branch of the Post Office, and the great extension of the responsibilities of this Department, following the taking over, at the end of the present year, of the business of the National Telephone Company, marks the present as a fitting time for this reform to be accomplished. The growth of the Engineering Department dates from the acquisition of the telegraph business in 1870, the purchase price paid being £7,809,000. Since that date a sum of over £100,000,000 has been expended in the purchase, maintenance, and extension of the telegraph and telephone business. With the acquisition of the trunk telephone system in 1896, at a cost of £459,000, a period of great activity was initiated; and up to the end of 1908 the total expenditure on telephone maintenance and extension has been £7,943,837. These figures are mainly quoted in illustration of the rise in importance of the engineering side of Post Office work under successive chief engineers.

Very important works have been carried out by the Engineering Department of the Post Office during recent years. These include the provision of a large mileage of underground telegraph wires connecting London with Edinburgh, with the west of England, with the Midlands, and with the south-east of England, the completion of which has ensured stability of service and practical immunity from breakdown. In other directions successful work has been done towards improving the efficiency and increasing the speed of telegraphic working. In the field of wireless telegraphy, following the acquisition of the Marconi and Lloyd's coast stations, improvements in the service have been brought about, and steps are now being taken to provide a range of thoroughly equipped stations round the coasts of the United Kingdom. In the telephone branch an enormous amount of work has been done in providing for the extension of the business, in the opening and the equipment of new exchanges, and latterly in carrying out plans for the consolidation of the existing plant and exchanges of the Post Office and the National Telephone Company. Experiments are constantly in progress with the object of improving the service, and the newer exchanges are claimed to represent the last word in telephone equipment. At the present moment the possibility of making use of automatic telephones in this country is under consideration. Of late, too, the Post Office engineers have been concerned with the equipment of the new General Post Office and the new electric power station.

This record gives a broad indication of the present extent of the work of the engineer in this department of State activity, but signs are not wanting that engineering science will make its influence even more largely felt in the future. The use of conveyor systems and other mechanical appliances for sorting-office work is increasing, and it is known that some important new developments in this direction are to be the subject of experiment. The employment of motor vans for the conveyance of mails is proving so successful that extensions of such services are likely to be made. Thus the influence of the engineer is being exercised in a gradually increasing number of departments of the Service.

A few figures may be quoted in illustration of the great interests for which the Engineering Department is responsible. The total mileage of wires alone which has to be maintained is 1,170,125, and when the business of the National Telephone Company is taken over this mileage will be largely increased. The mileage of wires of the telephone system has increased in the last ten years from 80,000 to 315,000. With this growth of business the staff of the office of the Engineer-in-Chief has steadily increased. In the year 1873, shortly after the telegraphs were taken over by the State, the staff of that office numbered 38; it now numbers nearly 300, and controls a vast army of men, at times totalling 10,000, engaged in the manual labour connected with the telegraph and telephone business. The district engineering staff, including clerks, numbers 807, and the total number of persons on the staff of the Engineering Department exceeds 1300.

SALARIES IN THE ENGINEERING DEPARTMENT.

It will not be without interest to make a comparison of the salaries paid in the office of the Engineer-in-Chief, and of the Secretary's Department of the Post Office. An analysis of the figures published in the annual returns of the Postmaster-General shows that in the financial year of 1873–4 the salaries of the Engineering Department amounted to £8057, and in the financial year 1910–11 the estimate is £39,130. The salaries in the Secretary's office, which were £39,122 in 1873–4, have now risen to £168,480. It will be seen that the salaries in the Engineering Department have been comparatively small, and it is not surprising to learn that a movement is in progress which has for its object the placing of the staff engineers, upon whom rests the responsibility for the spending of large sums of public money, on the same footing as the clerks in the Secretary's office. At the present time, while a second-class clerk in the Secretary's office can reach a *maximum* salary of £500, the *maximum* available for a first-class engineer in London is only £350. This would appear to be a real grievance. An assistant superintending engineer is paid a lower salary than an ordinary second-class clerk in the Secretary's office, and the starting salary of a superintending engineer is less than the *maximum* salary of a second-class clerk. The result is that the Post Office is not attracting the right type of man in its Engineering Department, and in the circumstances it is not surprising that those leaving engineering schools and colleges go elsewhere. This is much to be regretted, since there can be no doubt that, in view of the complicated technical problems which are now awaiting solution, the Post Office needs the services of the best men available.

It is not suggested that the work has not been well done in the past, and the names of men of great attainments who have been associated with it are well known. The truth is that the character of the work is gradually changing as the sphere of operations of the engineer becomes a wider one. The existing staff has grown up with the Service, and has won, by the slow process of trial and error, the useful experience which belongs to the pioneer in any new field. It was perhaps inevitable that such should be the case, but some of the work which appertains to the Post Office engineer has been impressed with the seal which distinguishes the exact sciences, and the new problems which will have to be faced call for the employment of the specialist who should be the product of the schools. A highly trained and capable staff would be the means of saving far larger sums of money than would be involved in the extra remuneration attaching to their services.

That the engineering staff are the custodians of large expenditure is emphasised by the fact that if to the salaries in the Engineer-in-Chief's office are added the wages paid for the engineering work as a whole, the total, which was £198,412 in 1873–4, is in the estimate for the current financial year £594,970, while the total cost of new telephone and telegraph works in the same financial year is estimated at a sum approaching £2,000,000.

The facts appear to establish a case for the elevation of the Engineering Department to a *status* commensurate with its position as perhaps the most important section in modern Post Office organisation.

POST OFFICE ENGINEERING DEPARTMENT, LONDON: EIGHTH ANNUAL DINNER.

THE dinner was held at the Connaught Rooms, Kingsway, W.C., on Tuesday, February 14th, 1911, Major O'Meara, C.M.G., Engineer-in-Chief, presiding.

The guests of the evening including the Rt. Hon. Herbert Samuel, M.P., Postmaster-General; Sir Robert Hunter, C.B.; Chev. G. Marconi; Mr. W. Duddell, F.R.S.; Mr. S. Z. de Ferranti, President of the Institution of Electrical Engineers; Mr. Alex. Siemens, President of the Institution of Civil Engineers; Sir John Gavey, C.B., ex-Engineer-in-Chief; Dr. Walmsley, Prof. Ewing, Col. Bain, Mr. G. Morgan, Mr. F. Gill, Mr. S. J. Goddard, Mr. C. A. King, C.B., Mr. J. Newlands, C.I.E., Mr. H. Hirst, Mr. J. E. Kingsbury, Mr. Dane Sinclair, etc.

After the Royal Toasts had been duly honoured, the POSTMASTER-GENERAL, in proposing the toast of "The Engineering Department," said:

Mr. Chairman and Gentlemen,—To my hands has been entrusted the duty of proposing the toast of the Post Office Engineering Department.

Most of the various branches of the Post Office expand from year to year and show a satisfactory growth, but your Department is able to display a rapid development, not merely in size, but in functions. You are always expanding, developing, changing. A colleague of mine was telling me a couple of days ago that he was once in a small draper's shop in an out-of-the-way country town in his constituency when there came in a man who had years before served in that same shop as an apprentice, and, having left the town for a long period, came back to re-visit the scenes of his youth. Looking about him, he said to the shopkeeper, "Well! I think that even after fifteen years I could lay my hands on anything in this shop." "Oh! no!" said the draper, with great pride in his enterprise. "Oh, no! *We moved the tapes about twelve years ago!*" Well! the Post Office Engineering Department has done much more than move the tapes about twelve years ago. You are in a constant state of adapting yourselves to new and changing circumstances. Beginning merely with the carriage of letters, the Post Office now is, I suppose, **the biggest electrical business in this country,** and in the future no one can tell to what extent your branch of the Post Office may develop. I look forward to the day when some ingenious engineer will have invented an automatic electrical ledger for the Savings Bank and for the Accountant-General's Department. I look forward to the day when I shall be able to sit at ease on occasions such as these while, after dinner, a highly intelligent gramaphone will be able to make a far more interesting and far more amusing speech than I myself would be able to originate. (Laughter.)

Continually new developments spring out of your enterprising Department. The postal work of the office is more and more assisted by mechanical appliances, such as the conveyors which are such a prominent feature in the new King Edward Building, and I am sure it must be a satisfaction to you, as it is to me, to see how the mechanical and electrical equipment of that great building has met with universal approval and praise. Further developments on the same lines will certainly come, and I believe that your Engineer-in-Chief is at present engaged, with the assistance of some of you, in devising more and more elaborate and ingenious forms of conveyors which are likely to prove, in the near future, one of the distinguishing features of Post Office work. There are some who believe that a State Department can use but cannot originate. Your Department will more and more prove the fallacy of that supposition.

Then, again, we have the successes during the last year with the loaded telephone cable between England and France (Hear, hear), which the Engineer-in-Chief tells us may, with proper adaptation and equipment, enable us to speak from London to Astrachan—an announcement which attracted much attention in the press, and has, I believe, been the cause of great interest and approval in Astrachan, and has led to a rapid rise in the value of landed property there! Certainly the new cable has enabled telephonic communication to be made between Paris and Glasgow and conversations have been successfully held, I presume, in a mixed French and Scotch accent between these two places. For myself, I am, of course, a layman in these matters and make no pretensions to any but a layman's knowledge in that respect. I am not quite so ignorant of electrical matters as the man who recently was mentioned to me by Sir John Gavey. He was persuaded that the way in which faults were discovered in submarine cables was to pump air into them and watch with a telescope to see where the bubbles came up. (Laughter.) But any of us who have the ordinary organs of hearing are able to judge—as I myself have been able to judge—by actual test the extraordinary efficiency of the new telephonic cable compared with the old ones which maintained communication between our country and France.

Then, again, during the last year we have had the inauguration of the new electrical power station at Blackfriars—so great a credit to your Department. I hold that it is right and proper that the public, to whom, after all, all these things belong and for whose benefit they are called into being, that the public should be acquainted with the work of a great department like the Post Office Engineering Department, and therefore it was a pleasure to me to invite the representatives of the press—both of the learned press, and of that greater press which is *not* learned (laughter)—to see what you had achieved at that new Power Station.

You have also quite recently established new standards of electrical illumination, and have been able to place the lighting of our great Post Office on a more scientific and, in many respects, a more satisfactory footing.

The Post Office, further, has given the lead to the nation in establishing a system of synchronisation of clocks by means of ingenious automatic appliances—a lead which, however, no one else has so far followed, but which may be adopted in the future by other and lesser institutions.

And furthermore, you have had cast upon you during the last twelve months a great part of the preliminary work of the immense transaction which is to take place at the end of this year—the transfer of the National Telephone Company's business to the hands of our Department.

All these things have been accomplished during the last year or so, and it is very evident that our Department does more than "move the tapes." You are always faced with new problems which you are always successfully solving, and so it will be in the future. Fresh developments are close at hand for conveyance of mails by tubes which are—if I may be allowed the expression—"in the air," and in that field your Department may have important functions to perform in the future.

Within the last twelve months, also, I have been fortunate in securing Treasury sanction for the overhaul of the wireless telegraphic stations round the coast, which will result, in the immediate future, in the removal of some of these stations to new sites and provision for better equipment.

Regarding the development of wireless telegraphy, we are honoured to-night with the presence of the illustrious originator of the practical application of wireless telegraphy—Mr. Marconi. (Applause.) Wireless telegraphy will—we are all confident—have vast developments in the future. And further, there is the great amount of work which will fall upon your Department when it has charge not only of all these various interests, but also of the whole system of telephonic communication.

You, gentlemen, therefore, are engaged in no trivial and stagnant business, but you are engaged in one that is profoundly important to our national life, and which is constantly expanding on every side into new fields of interest and into new fields of usefulness.

Well, all this imposes on the Engineering Staff of the Post Office the duty of keeping in constant touch with all the latest developments, both of theoretical and practical engineering science, and in that task and in that duty you have, of course, the fullest encouragement and sympathy from those who have the honour to be at the head of the Department.

Mr. Stubbs and the other delegates have rendered useful service to themselves and to the Department by the work which they did at the recent International Conference of Telephone Engineers.

Mr. Purves and Mr. Martin have been acquiring fresh and useful knowledge in the United States, which they will import into this country on their early return and which will be of great value to themselves and to the Department at large.

And I think you are greatly to be congratulated on the admirable journal which you publish from time to time and the less technical articles in it, which I read, of course, with the greatest interest, which helps to maintain a high standard of scientific knowledge.

Some changes in the organisation of the Engineering Branch are under consideration, and will be necessary in order to assist the branch to adapt itself to the changed conditions of the work with which it has to deal, but this is not the occasion on which to dwell (laughter) upon delicate and difficult matters of that kind, in addition to which the Treasury (laughter) have to be consulted. But, as you are aware, we have been able to accomplish a very welcome improvement in the status and remuneration—an important thing—(laughter) of the first class staff-engineers, securing to them, not for a moment, would I assert, the remuneration they deserve, but, at all events, the remuneration which may be expected to command the services of men of the calibre needed. Now, after acting for a year as Postmaster-General, I am much too wary to give anybody a pledge about anything, or make any promise about any staff question on any occasion, but it may be that sanguine persons might think these improvements in the pay of the first class staff-engineers may possibly, in the "dim and distant future," be a forerunner for others of better things to come.

You are fortunate in having now as Secretary to the Post Office Sir Matthew Nathan, whose recent bereavement prevents his attendance at these functions. He is, as you are aware, himself an engineer, and not merely an engineer by training, but he has his heart in the engineering profession. And you are fortunate also in having as the Chief of your Department the Chief Engineer, Major O'Meara, who is full of zeal for his work and enthusiasm for his Department. I do not imagine that he is able to please everyone; if he did, it would prove conclusively his unfitness for the post which he holds, but he has certainly escaped that great danger which afflicts so many people in the Civil Service, of being ready to be content with things as they are. He is always on the watch to improve the organisation, the status and methods of the Department, and he has most closely at heart its real and abiding interests. I ask you, therefore, to drink to the toast of "The Engineering Department" of the Post Office. Long may it progress, conquering field after field of applied science for the benefit of the country which we all serve. I couple with that the name of Major O'Meara, the Chief Engineer. (Loud applause.)

The CHAIRMAN replied:

Mr. Samuel and Gentlemen,—We must thank Mr. Samuel very much indeed for the kind and generous words in which he has proposed the toast of the Engineering Department. He has alluded to the unfortunate absence of Sir Matthew Nathan from our gathering to-night, but we know the very real interest he takes in us—he has on more than one occasion attended our meetings at the Institution of Electrical Engineers—and it will be agreed that no member of the Post Office has contributed more to the success of our Department.

The Postmaster-General has told you how wide is the field we are covering. We all know how rapid has been the progress in almost every branch of engineering with which we are brought into contact, and it is for that reason, I suppose, that we cannot learn our profession merely from text-books. We must have our Parliament, and it is a good thing that we have such an institution, for it is entirely due to the broad-mindedness with which engineers look upon their profession, and the open and public way in which they discuss the difficulties they meet, that we are enabled to progress at the present rate. Perhaps I may remind you that the Postmaster-General himself has shown his interest in our profession, for it is not so many days ago that he himself appeared in our Parliament House on the Thames Embankment. (Applause.)

We know—at least, *I* know—that a short while ago a proposal appeared in one of the papers suggesting that as a matter of fact it would be a very excellent thing for us if our members of Parliament had to pass examinations. (Laughter.) The suggestion was " made in Germany." Well, whether it is a good thing or not, I may say I do not think that it is entirely a new idea. A few weeks ago I was sitting next to a gentleman at a dinner party whom I had not met before, and in conversation the subject turned on to Eastern questions. I mentioned to him that I had myself been in Burmah, and thereupon he opened out on the subject of his own occupation, which had taken him to Siam. Just at that time the death of the late King had been announced, and, knowing the conditions in the East, I remarked that it was a curious thing that a country like Siam should have succeeded in producing a man like the late King. " Oh ! " he said, " it's nothing new in Siam. As a matter of fact Siam has been very fortunate in her kings ; they have been wise men, and had it not been for the fact that I myself am engaged at the present time in going through the records of the country I would not have believed the wisdom they have shown." To illustrate this, he mentioned the following incident. Some one hundred or two hundred years ago an alien—a Greek—went to Siam to assist in some of the big undertakings that this country had in hand, and he succeeded not only in amassing wealth, but also in obtaining very great influence over the people of the country. The King was so struck by his ability that he decided to appoint him Prime Minister. But naturally the inhabitants of the country did not wish for that, and the councillors objected very strongly. The records go on to say that the King called his council together, had a discussion with them, and finally got them to acquiesce in the proposition that the best man in the country should be his Prime Minister. " But," said his councillors, " how are you going to determine who is the best man ? " " Well," said the King, " we can determine that—*we will have an examination.*" (Laughter.) Well, gentlemen, this neighbour of mine told me that the examination consisted in the determination of the weight of a big, old, heavy gun which weighed something near twenty to thirty tons, and the biggest weighing machine in that country enabled them to weigh something in the neighbourhood of 10 lb. only! (Laughter.) My neighbour turned to me and said, "How would you have done that?" So I told him how I would have done it. "Oh!" he said, "*you would have been Prime Minister of Siam,* for that is exactly how the Greek solved the problem." My neighbour added, "I am surprised," so I apologised and said, "I should have told you before I began that I was trained as an engineer."

As the Postmaster-General has told you, we are dealing with new things, and it is not surprising the Press takes a great interest in us. The Press has always taken a great interest in the great National Institution at Westminster, with which the Postmaster-General is so closely associated, and, after all, when you come to look at the situation, is it not largely the work of the engineers that has provided work for Parliament? I think so; it is the work of the engineer which makes for the material progress of civilisation, and which has led, I think, to the consideration of many of these problems in Parliament for reaping the greatest advantage from them to promote the social welfare of the people. We know that only last week 'Punch' considered that the "Declaration of London" of the engineer was well and truly laid.

We are coming now to the end of another chapter in the history of the Post Office. Only a few days ago Lord Justice Fletcher Moulton, at the Institution of Electrical Engineers, in proposing the toast of the Institution took us back to the early days of telegraphy, when the first chapter of the activities of our Department opened. And now the Postmaster-General is engaged in writing the final paragraphs of another chapter of post-office history. He is now the prepossessing Postmaster-General, and next year he will be in a further sense the post-possessing Postmaster-General.

In conclusion, I again wish to thank the Postmaster-General most sincerely ou your behalf for the very kind words in which he has proposed the toast of this Department. (Cheers.)

Mr. W. SLINGO, in proposing the toast of "The Visitors," said:

Mr. Chairman and Gentlemen,—I have been attached to the Engineering Branch for the past twelve years, and this is the first occasion on which I have had the honour and privilege of standing up before you. Naturally, this makes me feel extremely diffident—I was going to say nervous—and very many of you know what is the depth of my nervous feeling when I am in a position of this kind. At the same time it is especially so when I have to speak upon a topic such as that now before me—to ask you to drink a toast. As you all know, I am not a speech-maker, and if I were called upon to design the very best possible punishment for my dearest enemy, I think I should prescribe that he should be compelled to sit absolutely still and listen to a speech, that he should not be allowed to express either his disgust or his disapprobation, and that the duration of the infliction should simply be measured by the intensity of the enmity between us. Now there is one little feature in to-night's function which fortunately averts the necessity for my making a speech: I have no enemies here to-night—at least, I hope not—and I might almost, therefore, proceed direct to the proposition before us. I have simply been asked to propose a toast—the "health" of our visitors. Now, when I was a young man, so far back that I almost forget it, I was very fond of an occasional dinner. It was not always possible, but on occasions I did get one, and I noticed that on those occasions the visitors were always a much better set than the visited, and that idea is forced upon me to-night with tremendous vigour. We are certainly very pleased, indeed more than pleased, to see so many visitors amongst us. On your behalf I extend to them a very hearty welcome, and a wish to see them here again. There are a few who have unfortunately been kept away. One of them is Captain Norton, the Assistant Postmaster-General. Now I know he is not happy. He could not get here to-night—he was otherwise detained. But I feel assured that his spirit is with us, and wherever his physical part is it is having a bad time, it is feeling unhappy, and I know that when the physical and spiritual parts reassemble to-night there will be an uncomfortable half hour for Captain Norton.

Now as to Mr. A. F. King. A telegraph dinner without Mr. King is like "Hamlet" without the Prince of Denmark. He always adorns any dinner attached to, or connected with, the Department. I think his spirit must be hovering somewhere at the far end of the table, but I have not been able to get into communication with it. There are so many bad media between us.

Coming to the visitors who *are* with us, I must refer first to the Postmaster-General, who has unfortunately had to leave us. Perhaps we can speak all the more freely because he has gone. He has added a grace and a charm to our gathering to-night. He is one of the very best Postmasters-General we have ever known, and a Chief of whom we are all proud. Do you know—I do not think you do because we are not as a rule politicians—I am not—but I believe there was some little commotion a month or two ago in the political world, a struggle for supremacy between two great parties—I think they call themselves Whigs and Tories? I am sorry that I have not yet been able to discover any great difference between these parties, but there was a great fear that we were in danger of losing our head, and the Post Office without a head would be something deplorable. There was a prayer that went up from all branches of the Service. It was very expressive, and ran somewhat on the lines of a petition that was eloquently raised many years ago. It ran thus—

> "Let laws and learning
> Arts and commerce die
> But God preserve our—Postmaster-General.

and He did.

Passing from the Postmaster-General, we have Sir Robert Hunter. There is no need for me to say much when his mere name is mentioned. Sir Robert Hunter is one of the great bulwarks of the Service; he is the man to whom we all turn in times of trouble and distress.

Our attention is drawn next to Mr. C. A. King. We all know Mr. King, and I think I can safely say that Mr. King knows the Engineering Department—I think I hear him say, to his pain—for if it were not for the Engineering Department his office would be a bed of rose-leaves (no thorns) and his staff would enjoy one long siesta in the land where it is always afternoon.

Then we have Sir John Gavey. Is Sir John one of us, or is he not? I cannot say without reference to a committee, but I do know he is right in the front of the fighting line.

Extending my review to those gentlemen outside the service, we have Mr. Siemens, President of the Institution of Civil Engineers, and Mr. Ferranti, President of the other variety. Mr. Siemens comes from very illustrious parentage, and he and his forbears have been associated with telegraphy right from its inception. Mr. Siemens is in the very front rank of telegraph engineers, and by his own personal industry he has attained to the very highest pinnacle of an engineer's ambition, the Presidency of the Institution of Civil Engineers. His presence to-night in that capacity certainly does us the greatest possible honour.

Mr. Ferranti was, is, and ever will be, a genius. He is a man who is always many years before his time, born too soon, so to say, but I know we shall all be delighted if he lives long enough to see his latest dream carried into execution, and all our factory chimneys and domestic flues made derelict. He is, indeed, one of the few men of whom it may truly be said, "His works do live after him."

Then we have the Chevalier Marconi. I am wondering why he has not been with us before, but we hope that he will be with us many times in future, notwithstanding the fact that he has taken away from us to some extent the reason of our being—we live on posts and wires—but we honour him all the more.

We have the manufacturing interest, which is exceedingly well represented to-night by the principal officers of the three great firms who are helping us now, who have helped us in the past, and will, I hope, help us in the future—Mr. Kingsbury, Mr. Sinclair, Mr. Hirst—all heartily welcome at our table to-night, and we are extremely delighted to see them.

The learned body is represented by Professor Ewing, and last, but not least, there are the representatives of the National Telephone Co.—Mr. Goddard and Mr. Gill are here in person, Mr. Franklin is here in the spirit, and several others are here in both. They are men to be honoured and esteemed. We are delighted to welcome them here to-night. They are foemen worthy of our best Toledo, and friends who are worthy of the greatest possible encouragement, and I am sure that in the end we shall be even better friends than we are to-day. We look forward to the time when many of them will sit at this table, not as guests, but as colleagues. When that time arrives the end of our struggles will be near. The time will soon come when the lion will lie down with the lamb, and the only remaining problem is, which will be the passenger. Gentlemen, I ask you to be upstanding and drink with the greatest sincerity and enthusiasm the toast to our visitors, coupled with the names of Mr. Alexander Siemens, President of the Institution of Civil Engineers, and Mr. Sebastian Ferranti, President of the Institution of Electrical Engineers.

Mr. ALEXANDER SIEMENS, President of the Institution of Civil Engineers, replying for the visitors, said :

Mr. Chairman and Gentlemen,—I think I should commence my reply by talking as President of the Institution of Civil Engineers, and, as such, I think I can give you very conclusive proof that I am very glad to be here, because by rights I ought to be sitting in the chair of a meeting of Civil Engineers, but I have preferred your company, and I hope that will be reckoned as merit. I am a little bit dissatisfied, but of course it cannot be helped, that I am a visitor, because I really began my professional career as a telegraph engineer. I was employed—I hardly like to say it—in '68, in Persia, to build that portion of the Indo-European line. I was not in charge, but there was one experience we had there which may interest you, seeing what a difference it is to build a telegraph line in, I almost said, a barbaric country—but the Persians think their civilisation superior to ours—but in a desolate country. We were setting out the line and taking straight cuts everywhere, a thing in which you cannot indulge in this country. I recollect particularly that between Caswin and Teheran we had a mountain with a peak, and we laid the line quite straight for that peak, I think for eighty miles—absolutely straight. We were very proud about that setting out, but not long after the line had been laid someone came and said, " Who was the idiot who laid that line ? " I said I was personally concerned in that, and inquired what was meant. He said the fellow had put the line right in the middle of the road; why on earth could he not have put it at the side? The explanation is this: The high roads in Persia are not all macadamised, in fact, they are rather vague, and the caravans go one way, and when that gets rather muddy they go a few feet either north or south—they don't mind. But the caravans soon found out that our line went straight for eighty miles, and that it was the shortest way. So they followed the poles, some one side and others the other, and that was how the poles got in the middle of the road.

There is a further story connected with this very same piece of line, and that was that the camels, which were mostly used for transport, liked to rub themselves against the poles and knock them over. Well, that was rather a drawback for an efficient service, and after consideration this was effectually stopped by making a mound of earth about six feet high, with a natural slope round each pole, so that the camels could not get near them. Well, long years afterwards I was consulted by a Royal Engineer, who had the telegraphs in the Soudan under him. He said he was a little bit in doubt how he should put his line, because there were elephants and giraffes about, and he was rather inclined to have a cable. So I recollected this experience of Persia, and said a cable was far too expensive, and would be very awkward to lay down, and all that; you make your telegraph line by making the poles high enough for the giraffes to walk under the wires, and make a mound of earth around the poles so that the elephants cannot knock them down; and, as a matter of fact, that is how the lines in the Soudan are laid. Therefore I may say that I feel quite like a telegraph engineer, and have a very friendly feeling to the Post Office Engineering Department. I need not say that the cables which come under your Department are also of great personal interest to me, and I may say that my first experience of cable laying was in '69, when we laid a cable in the Black Sea, also in connection with the Indo-European telegraph. And that cable was so far interesting because it was a very light cable—just a core with a serving of jute and then taped with copper strip. That was all. And I recollect that I was put at the brake, and I had to regulate the brake so that the cable should not run out too fast. The arrangements were a little primitive. We had only an ordinary commercial steamer to lay the cable. The brake drum had just been rigged up, and the counter was on the shaft of this main drum. So I was standing at the periphery with a number of brake-blocks all round the wheel and two strips of iron, and there was a rope and shift-screw which had to be tightened or loosened to regulate the going out of the cable. At the same time I was expected to look at the counter whenever a Russian ship, which was taking observations for us, was making certain signals. Well, I could not let go of the brake and I could not look round, and the result was that the cable was laid without any very accurate observations. We have done it differently since, but the two things which were interesting were that this brake was tied with a rope to a hook, and the rope broke, and so the wheel turned with the brake and everything. There was a piece of wood handy, and I put this piece of wood so that it caught the edge of one of the brake-blocks and stopped it, but I am still surprised the cable did not break. At another time the cable was going too fast, so I caught hold of it by my hand and held it. I must confess that my cable experiences since this have been different, but I thought it might interest you to hear how in the days of old cables were laid. As I am sure that Mr. Ferranti can tell you a much better story than I can, I will sit down, thanking you very much for the toast with which you have honoured the visitors.

Mr. S. Z. DE FERRANTI, President of the Institution of Electrical Engineers, also replied, as follows:

Mr. Chairman and Gentlemen,—I must thank you very much for allowing me to be in this position to contribute my small share towards thanking you on behalf of the visitors here to-night for your kind hospitality. I think it is rather unkind of Mr. Siemens to say that I will tell you a better story than he has done. I thought what he told you about the telegraph line going straight to the mountain, and so forth, was difficult to beat. But still, I should like also to tell you something in the nature of a story, although a personal one.

My first connection with your Department was about 1887—very long ago, I am sorry to say—and you would hardly imagine what we came into contact over. It was nothing more or less than my attempt to dispute with the Post Office the monopoly of the earth (laughter), as the Post Office at that time—most unfairly I thought—claimed that it had the sole right to use the earth. What was the use of being in a free country to find that it had such a monopoly as that? All that I wanted to do was to connect one point in my high-pressure electrical supply system to earth so as to make sure that the outers of the concentric cables should not be raised above their natural pressure; but this was a thing impossible according to the then existing regulations. It was considered wrong that anybody else should make contact with our Mother Earth. (Laughter.) And so there was this very great difficulty presented to us, and it was a matter of fighting with one's best enemies to get things so altered that we could make our electric power system safe and satisfactory. Eventually it was discovered that quite the safest thing to do was to make connection at one point of our high-pressure system to earth, and that it did not matter to the proper working of all the delicate apparatus with which you have to deal. And so, you see, eventually we were both able to possess the earth in perfect peace.

This happy state of affairs was, however, broken at quite an early period, when a curious thing happened, or was brought about at the supply station of the London Electric Co., of which I was then engineer—about 1889. In the first instance, it was necessary to buy the best cables we could in order to transmit the 10,000 volt current to London, to be used there after transforming to a lower pressure, and then distributed to customers. There was, of course, very little experience in cable-making at the time. We tried to get the best cable we could, and perhaps we were mistaken in the quality we had obtained. The result was, however, that we got, and laid, two concentric cables mostly along the South-Eastern Railway from London Bridge and Charing Cross. Both turned out faulty, and for some reason or other the fault developed on the outer conductors. Furthermore, it was found that we could not transmit a current with a pressure of 10,000 volts on either of these two cables because in practice the insulation was insufficient from the inner to the outer conductor. Well, in order to overcome the difficulty we modified our system—we used a system which did not connect to earth, and tried to get an equal potential difference between the inners and outers, making 2500 volts, and so having a total pressure of 5000, saw we should have to go on in this manner until we had new cables.

Well, one day we had not sufficient machinery in London, and therefore had to run from Deptford Station, and one of those cables failed—even at the reduced pressure—about four o'clock. It was getting dark ; fortunately it was not the worst time of the year, but in another hour and a half or so the lights would have to be shut down in the West End. I do not know what name you would give it, but I determined to take the earth into my service. And, as we had very good earth connections in London, and good earth connections at Deptford—about seven miles apart I think the points were—I determined that we would run our supply that night upon a single conductor, bringing the current back through the earth. Well, it is almost forgotten now what happened, but I need hardly tell you that telegraphic communication with the Continent was stopped. The papers said it was an electrical storm which had stopped all communication between ourselves and the Continent as far as Rome. How far this was exactly true I do not know, but I know that when we came to talk about the cause I knew what had happened—and the principal engineer of the Post Office knew. I was very penitent, but said it was the result of necessity and would not occur again, and I think the public got no further on that occasion than an electrical storm as a detriment to the public service

Well, gentlemen, I must thank you very much, as President of the Institution of Electrical Engineers, that you have allowed me to do my share in replying for the guests. There are many of you who are members of the Institution, and many others, I am sure, who will join.

The Postmaster-General has reminded you of the important work you do and of the great technical knowledge required for carrying it out. I wish the public at large could appreciate more fully the working of this wonderful Engineering Department of the Post Office, which does so much for every person in this country. You have done great things already, but, as the Postmaster-General has said, your Department is constantly developing, and there is, I am sure, still more before you to do. This work means that you want the very best of engineers and electricians, that the men who form your Department must be of a better and better quality and standing—if such a thing is possible—to meet the developments as they go on, and I think it naturally follows that the public, in whose interest you work, must expect to pay for the high standard they require. This is not a matter on which an outsider can, or should, talk, but I think it is a concern which, if the public appreciated the fact, requires to be well paid, and better still in the future when great things in the shape of the more complex and delicate work have to be accomplished to satisfy their needs.

You have, of course, made, and are making, constant developments, but when I think of the amount of knowledge which you and your engineers must possess, it quite surprises and frightens me. There are not only all the things you have heard of, but we can imagine that there will be an immense mechanically propelled traffic department which will take the mails rapidly all over the country. That is in itself a vast branch of engineering, which, it seems to me, comes properly within your Department, with all the additional knowledge required for that purpose. Then who knows but that that will be insufficient in the future, and some new means will be wanted for the more rapid transmission of the mails? Some day, certainly, a part of your Department may have a vast aëroplane scheme, with a great fleet of aërial ships, perhaps, travelling at 200 or 250 miles an hour, probably driven by gas turbines, and taking all the mails all over the country in a time which we now consider as ridiculous for its shortness. Such are some of the possibilities before your Department, and it is certainly a great thing to belong to such a service. Thank you very much for allowing me to reply. (Applause.)

In proposing the health of the Chairman, Mr. TREZISE said:

Gentlemen,—The toast that I have to propose is, I am sure, one you will receive with acclamation—it is the health of the Chairman.

I would say at once how much I appreciate the honour of being invited by the Committee to propose this toast. When asked to do so I acceded with alacrity, for I regarded the task as one of both pleasure and comparative ease. The pleasure I need hardly say remains, but with reflection the ease has diminished. My difficulty lies in the choice of the best mental attitude in which to approach the toast. If I pitch my remarks in a spirit of adulation I may lay myself open to the suspicion of wishing to flatter my Chief, and if, on the other hand, I assumed a critical attitude, I run the risk of committing an act of insubordination towards a superior officer. In the hope that good intention will ensure pardon I am going to be a little critical.

Everyone who has been brought into contact with Major O'Meara will have seen at once how thoroughly he has at heart the good and efficiency of the Service, and he is constantly showing us, too, that he recognises the fact that the efficiency of the whole depends upon the efficiency of the units. He has not, of course, given to each one of us everything that we should have liked for ourselves. The Postmaster-General has told us that if he had done so he would not have been a good Head of the Department. I presume we should all have been Assistant Engineers-in-Chief, and there would have been nobody left to do the work of the rank and file. But, gentlemen, Major O'Meara has always been ready to consider our case and to listen to the representations of any of us, and as an individual I should like to take this opportunity of thanking him for the invariable kindness and consideration he has always shown to me.

But—and it is here that I have to speak in a critical vein—towards one member of the staff he has not shown that consideration and kindness. The particular member whom he has not considered, whom he has overworked, regardless of consequences, is the most important one—himself.

It has been said, What would Napoleon have done without his rank and file? But Napoleon's soldiers would never have won their battles without their general, and our Chairman ought to recognise that the chief is the one man who should take particular care of himself, and whose place cannot be efficiently filled by another.

We all know of the multitudinous duties and responsibilities of the Engineer-in-Chief of the British Post Office; those duties are not confined to work inside the Department; they extend, and I think to an increasing degree, to work outside the Post Office. Then, in all branches of official life there are many things which need not be done, but which are all the better for being done, and as regards our Chairman these things *are* done. I cannot, I am afraid, claim to have been a very regular attendant in the past at all the social and other functions connected with the various clubs and societies we have in our Department, but whenever I have attended I have invariably found that Major O'Meara was present. His presence on these occasions must make for the good of the Department, and I mention it as one of the many ways in which he has not spared himself where the general good is concerned.

In conclusion, I may remind the younger members of the staff that the efficiency of a body mostly depends upon loyalty amongst its members, and especially towards its head, and it is the duty of each one of us to show our appreciation of our Chief's ready sacrifice of himself on all occasion by unswerving loyalty to him, and I know that I can in the name of all assure him of that loyalty. We hope that Major O'Meara will long remain with us, and we wish him good health and every happiness. Gentlemen, "The Chairman."

Major O'MEARA (the CHAIRMAN) replying, said:

Mr. Trezise and Gentlemen,—I have to thank Mr. Trezise very much indeed for the very kind way he has proposed my health, but I think that he has spoken of me in much too flattering terms. I am certainly proud to be the Chief of the Engineering Department of the Post Office. I really think my motto should be taken from the maxim which, I believe, is Bacon's:

> "Every man is a debtor to his profession."

I am trying to be a debtor to my profession, gentlemen, and I can only be that debtor because—fortunately for me—you are so willing to share the burden of my debt. I feel I could never wholly pay my debt—it is a very big debt—were it not for your kindly assistance, and I thank you all most heartily for the very generous support you have always given to me.

The musical entertainment included such well known artists as Miss Annie Bartle, Mr. Ernest Pike, Mr. Sivori Levey, Mr. Willie Rouse, and Mr. Conway George. Time did not permit of these artists giving a varied programme, but mention should be made of the beautiful rendering of the songs selected by Miss Annie Bartle and Mr. Ernest Pike, whilst Mr. Sivori Levey, Mr. Willie Rouse, and Mr. Conway George were greatly appreciated in the lighter vein. The Grand Hall of the Connaught Rooms, which was most tastefully decorated with palms and flowering shrubs, is probably the most perfect dining hall in London, the atmosphere during the whole evening being all that could be desired. The Committee are to be heartily congratulated upon the great success achieved.

NOTES & COMMENTS

OUR ANNUAL DINNER.

THE venue of the Annual Dinner this year shifted to the new and beautiful Connaught Rooms in Kingsway, and, as in previous years, the re-union was a great success and thoroughly enjoyable. According to our custom we reproduce the speeches for the benefit of those who were prevented by distance, business, or ill-fortune from being present, and we assure them that we would also, if we could, transmit to them the feeling of fellowship and good cheer that animated the assembly. Mr. Samuel's witty speech irresistibly reminded one of Sir Henry Babington Smith, whose eloquence has been a feature of previous gatherings. In language of increasing warmth he expressed his appreciation of the work of the Department, its Chief, its principal officials, and its JOURNAL.

Having led his hearers up to the seventh heaven of expectancy, he brought them back to earth by the magic word "Treasury," and the lifting of the veil so far as to explain that certain improvements in the status and remuneration of a body of engineers would secure to them, "not what they deserve," but "remuneration which may be expected to command the services of men of the calibre needed."

Sir Matthew Nathan, Secretary to the Post Office, was again prevented by unfortunate circumstances from being present.

The presence of the Presidents of the Civils and Electrics lent special distinction, and the Chevalier G. Marconi was also given a warm welcome.

Old friendships were renewed and new ones made, and there can be no doubt of the good effects resulting from opportunities for social intercourse such as these gatherings afford.

CONFERENCE OF POST OFFICE ENGINEERS.

In connection with the Society of Post Office Engineers a representative Conference was held in London on January 21st and 22nd to discuss various service questions, with a view to more effectively representing to the Department the present unsatisfactory position of all classes of engineers, and more successfully pressing for the removal of—in some cases—long-standing grievances.

The gathering possessed features of quite remarkable interest. It was the first occasion upon which engineers of all grades, and, with one exception, of all districts, had met in conference. Hitherto the affairs of the society have been directed by a small elective committee, whose mandate was necessarily somewhat nebulous, and whose policy was only capable of approval or otherwise by their re-election to office. Such an arrangement, though flexible and convenient, possesses manifest disadvantages in a society which aims at being fairly representative of the views of the whole staff, and hence the Conference—which it has been decided to hold annually—was held to supplement and strengthen the existing organisation, by ensuring that on all such questions as can be foreseen and discussed, the policy of the Executive shall be definitely and undeniably in accord with the declared views of not only every grade, but of every section of the Engineering staff.

This, then, was the *raison d'être* of the Conference. Whilst, therefore, from this point of view it marks a notable advance, and may well prove to have an historic interest, the impressions which will most vividly remain with those who were privileged to take part in its deliberations were on another plane of interest, and were threefold.

First, the remarkable *esprit de corps* displayed, and the readiness with which the delegates not simply grasped, but entered into sympathy with the opposite view. Certain army regiments are understood to exhibit in a supreme degree the virtues of personal loyalty to each other, and that undefinable sense of corporate helpfulness which "in honor prefers one another." Such a spirit is an untarnished glory to officers of any rank, and to the real presence of such a spirit the scribe of the Conference is compelled to testify. It was a delight to be there.

The second powerful impression created was the intense seriousness and sense of responsibility which was exhibited throughout the proceedings. The feeling which the atmosphere of the Conference produced was that the resolutions adopted were no mere formal expressions of more or less pious opinion, but a solemn registration of deep-seated convictions. The absolute unanimity of opinion shown in the discussion of all the important resolutions, and the tacit exclusion of all that was trivial and merely transient, was in itself a revelation. One longed for an official delegate to faithfully represent to the Department the depth, sincerity, and unanimity of the views expressed.

Such a delegate would have been useful, too, in transmitting a third outstanding feature of the Conference, viz. the fairness with which the Department's interests were always represented in the discussions. The spirit and methods of the reckless, irresponsible partisan were entirely absent. That blessed principle of asking a lot that you may get a little was blessedly absent. Both sides were presented, both interests considered. The delegates never forgot that they were responsible officials, co-operating in the administration of a highly complex and important branch of the service of the State. And though at times the sense of bitterness born of grievances long unredressed swept like a strong current through the Conference, it would be a manifest dereliction of duty on the part of the Conference scribe not to record the fact that in no case were suggestions of policy which might be fairly said to be the outcome of such stress of feeling seriously considered. It was a business conference of business men, conducted by business methods, and arriving at business-like conclusions.

The tactful conduct of Mr. H. C. Price in the chair and the excellence of the arrangements made by the General Secretary (Mr. Wenman) were matters of general praise. J. M. C.

THE FUTURE DEVELOPMENT OF THE TRUNK TELEPHONE SYSTEM OF THE UNITED KINGDOM.

The statistics of the growth of the trunk telephone system of the United Kingdom furnish an interesting record which is probably unique among the public services. Prior to 1907 expansion had been largely influenced by the tenets of the policy under which the telegraph system had been developed.

The introduction of the zone system in 1907 marked a new stage in the art of controlling and operating the trunk lines. The consequent changes in method increased the average revenue-earning capacity of the existing plant, and afforded a solution to the problem of equalising delay on traffic originating in towns of the same commercial or geographical group. These results, which will doubtless lead in time to standardisation, unfortunately have not been accompanied by the equally important (if not more important from the engineering point of view) desiderata of improvement and equality in transmission efficiency.

The trunk routes converging on our large zone centres are becoming congested. Terminal underground sections are increasing in length. The privilege of communication with the Continental cities is limited to a few zone centre towns, served by the heaviest conductors; and the same limit applies practically to communication between Irish cities and the greater part of England. The transmission efficiency over available channels between widely separated English towns, not in themselves zone centres, is scarcely good enough to warrant the connection of such towns to Continental cities.

The time seems ripe for the evolution of a policy based on sound engineering and commercial practice which shall remove these disabilities and provide for future development.

In the light of present-day knowledge the fundamental principles of such a policy might be:

(1) The selection of *primary centres* (*i.e.* long-distance trunk exchanges), so situated that main (heavy gauge) lines can be led into them without the use of underground cables; or if the use of the latter be unavoidable the cables should be loaded.

(2) That in a given area served by a primary centre (and the areas will not necessarily coincide with the existing zones) the design of junction circuits between the primary centre and the various local exchanges shall ensure equality of transmission so far as practicable for all subscribers in the area, that is to say, for a given area there shall be a standard of transmission efficiency for any circuit which may be connected with a trunk line at the primary centre.

In determining the location of a primary centre, full consideration should be given to all the engineering, commercial, and traffic factors which have a bearing on the problem, and most of the conditions which have caused the transfer of large commercial factories from large towns to rural districts will require consideration in preparing schemes for establishing primary centres.

The selection of these centres and the provision of trunk lines between them must, to a great extent, be governed in the earlier stages by the disposition and condition of the existing plant, but serious problems loom in the near future.

On some of our main telephone routes we are already in sight of the ultimate carrying capacity of the pole lines as limited by our present standards of construction, and to some extent by the Department's statutory powers and obligations. The practicability of loading aërial lines and the advantages to be derived therefrom are limited by the comparatively low minimum average of insulation resistance attainable in our climate with the present standard insulators.

These, however, with many other technical problems involved in framing a comprehensive policy, are only such as engineers delight to unravel in their progress towards efficiency.

THE ENGINEER AND THE STATE.

We publish elsewhere an article which appeared in the 'The Times Engineering Supplement' on February 1st, and in welcoming the interest 'The Times' has taken in Post Office engineering work, we must acknowledge that the state of affairs indicated does exist, and express regret that it has not been remedied before public attention has been aroused. The subject of the relation of science to the State and the extent to which certain Government Departments are engineering enterprises would form an important and interesting discussion too lengthy to be treated in this issue, but we hope to deal with it at an early date. For the present it must suffice if we record the fact that the telephone undertaking is essentially an engineering enterprise, demanding for its successful maintenance and operation the services of trained and competent engineers unhampered in the exercise of their functions. Such a statement made in connection with any other telephone undertaking than that with which we are immediately concerned would be regarded as unnecessary, but the function of the engineer in the State telephone enterprise has not received that measure of recognition which it merits, and which will, when granted, help to promote the successful working of the concern, as is evidenced by the result of such policy in telephone companies in this country and America.

It seems to be the common opinion that the grant of any larger powers of decision or control to the engineer can only be made at the expense of the prestige and control of the Administrative and financial officers. This inference is not warranted, and nothing is further from the desire or intention of the engineer than to usurp the functions of any department which is in any degree responsible to the Postmaster-General for the working of the vast undertaking he conducts. But, as the Postmaster-General stated at the Engineering Department Dinner, the Post Office is the biggest electrical business in this country—a business which is constantly expanding on every side into new fields of interest and into new fields of usefulness.

The man of science and the man of affairs both have their respective duties and responsibilities, and their co-operation can be obtained without one entrenching on the field of the other. Sooner or later, however, must come a recognition of the substantial assistance which the engineer renders to the administrator and to all who aspire to become leaders in public affairs and in commerce. The conduct of affairs is becoming more and more scientific, and all this encourages us to hope that engineering work in the Government service will soon be appreciated at its proper value and the sphere of the engineer gracefully acknowledged.

NEW ANGLO-BELGIAN LOADED TELEPHONE CABLE.

It will doubtless still be fresh in the recollection of our readers that the first submarine coil-loaded cable was laid last year in the English Channel, for Anglo-French telephonic communication; and there can be no doubt that its advent marked an important epoch in the development of international communication, not only, nor indeed principally, on account of the improvement in communication with France which it gives, but because of the possibilities it affords of extensions in other directions where the benefit of loading is even more urgently needed. We have pleasure in announcing that an additional Anglo-Belgian cable has now been authorised, and that it will be laid between St. Margaret's Bay, near Dover, and La Panne, in Belgium, a distance of 47¼ knots. The cable will contain four copper telephone conductors, each weighing 160 lb. per knot, and insulated by gutta-percha weighing 150 lb. per knot. The four wires will be loaded, so as to form two telephone circuits, and a third circuit will be superimposed upon them which will also be loaded.

The practical outcome of the arrangement will be that three telephone circuits will be obtained from four wires, and each of the circuits will be much more efficient than the two at present working between the same points on wires of exactly the same weight.

The method of superimposing referred to has recently been applied to aërial circuits in America, but it is of interest to note that it was experimentally tried in this country, and found to be practicable three years ago.

WIRELESS LITIGATION.

The judgment given by Mr. Justice Parker in the action brought by Mr. Marconi and his company against the British Radio-Telegraph and Telephone Company on February the 21st last concludes the most important legal action yet taken regarding the position of wireless telegraph systems. The hearing of the case commenced on December 13th, 1910, and occupied several weeks. As is usual in litigation proceedings on patents the defence attacked the validity of the principal patent at issue, but the fight mainly turned on questions of oscillation transformers and their equivalents together with questions of strong and weak couplings. Mr. Marconi was given what is practically an unqualified verdict. A decision so definite in its terms, and conveying so broad an interpretation of the Marconi tuning patent of 1900, necessarily affects the position of the smaller fry of wireless telegraph concerns very seriously, perhaps the more so as they are now between the devil and the deep sea, being bound on the one hand by the judgment given, and on the other by the restrictions as to character of transmitting appliances imposed by the Postmaster-General in conformity with the regulations of the International Radio-Telegraph Convention. The first demands that the broadly interpreted Marconi patent be not infringed, whilst the latter practically insists on a method of syntonic transmission embracing modern practice in syntonisation of the circuits being used.

The whole case was closely argued out, and the written judgment forms an interesting and instructive document which should serve to throw light on the legal view of the wireless telegraph position generally, and form a useful guide for future reference.

At the Annual General Meeting of the Physical Society of London, held on February 10th, 1911, Major W. A. J. O'Meara, C.M.G., was elected a member of council.

Mr. F. L. Henley has been appointed a member of the Engineering Standards Committee, and is now serving on the sub-committee dealing with the standardisation of earthenware pipes.

INSTITUTION NOTES.

COUNCIL NOTES.

THE twenty-sixth meeting of the Council of the Institution of Post Office Electrical Engineers was held at Cardiff on November 29th and 30th last, A. J. Stubbs, Esq. (Vice-President), in the chair.

The following brief notes are inserted as relating to matters of interest to the membership as a whole.

METROPOLITAN HEADQUARTERS.—The Chairman reported progress in the negotiations for the use of the New Lecture Theatre of the Institution of Electrical Engineers on the Thames Embankment Except for the matter of minor details arrangements had been satisfactorily concluded, and it was agreed that it would be most suitable for the transference of the Metropolitan Centre meetings to take place in connection with the first meeting of the New Year on January 19th. The Council resolved that their very best thanks should be accorded to Dr. Walmsley and the Board of Governors of the Northampton Institute for the generous hospitality extended to the Institution in the use of their Lecture Hall.

LENDING LIBRARY.—It was reported that the supplement to the Library Catalogue was in hand, and would be issued shortly.

The Library Committee wished to have attention drawn to the fact that very few recommendations for books had been received from members lately. They would be pleased to consider more applications of this nature.

MEMBERSHIP.—A net increase of twelve in the membership since the opening of the current Institution year was reported by the Secretary.

A resolution to extend the honorary membership of the Institution to Mr. G. M. Carr was carried unanimously, the Council expressing their appreciation of the work done by Mr. Carr during the formation and early days of the Institution.

CLERICAL REPRESENTATION.—After a lengthy discussion on the subject of additional clerical representation on the Council, with a view to securing a more proportionate representation for the clerical members, the question was postponed and a sub-committee appointed to consider and report upon the matter at the next meeting.

TECHNICAL PERIODICALS.—A proposal to reduce the number of circulating technical periodicals was considered, the suggestion being that advantage could be taken of the money saved thereby to print more Institution papers. The alternative of reducing the number of members per periodical was suggested, and it was finally agreed that before any re-arrangement was effected members should have the opportunity of expressing an opinion as to the method most acceptable to them.

INVENTORY STAFF.—It was arranged that the various inventory groups should be placed on separate circulation lists for technical periodicals, distribution of literature, etc.

PRINTED PAPERS.—A paper by Mr. J. McCandless on "Electric Train Staff Apparatus" was passed for printing.

LOCAL CENTRE MEETING.—The Council, on November 30th, attended the Local Meeting of the South Wales Centre, when the lecture, reported in our last issue, was given on "First Aid: its Aims and Objects."

The twenty-seventh meeting of Council was held in the G.P.O. West on January 17th and 18th, 1911, A. J. Stubbs, Esq., in the chair.

PRESIDENT'S AWARD.—Ten notifications of intention to compete for the President's Award were reported to the Council. It was arranged that Mr. J. E. Taylor, Mr. A. E. Cook and Mr. M. Ramsay should be invited to form the board of adjudicators, power being retained by the Council to add another member to the board if found desirable in consequence of the subject matter of the competing papers.

Technical Periodicals.—Replies to the circular letter issued by the Council to the various centres asking for votes of members to be taken in respect to the alternatives under consideration were not to hand in sufficient number to enable the Council to arrive at a settlement of the question.

Clerical Representation.—The Committee of the Council appointed to consider this matter submitted a detailed report of their deliberations. These were very carefully reviewed by the Council. Recognising the fact that the total membership of the Institution has grown from 755 to 848—nearly 100 increase—it was considered that an additional representative on the Council was justified. It was ultimately decided that, subject to the necessary approval of members under the provisions of Rule 28, steps should be taken to amend the rules to provide for an additional representative on the Council, and that the position should be held by a provincial clerical member. (The present representation of the Metropolitan and Provincial membership is 1 to 69 and 1 to 163 respectively.)

Membership.—The statement of membership up to January 12th was as under:

No. on roll March 31st, 1910		830
By resignation:		
Home	16	
Foreign	1	
By retirement, transfer, or death:		
Home	9	
Foreign	1	
		803
New members:		
Home	35	
Colonial	10	
		45
		848

Printed Papers.—The under-mentioned papers were passed for printing: "Power," by Mr. H. O. Fleetwood; "Fundamental Principles of Internal Combustion Engines," by Mr. P. Dunsheath, and for printing in abstract, "The Forked Quadruplex," by Mr. A. E. Land.

LOCAL CENTRE NOTES.

METROPOLITAN CENTRE.

On December 12th last Mr. J. G. Lucas, of the Headquarter Staff, read a paper before the Metropolitan Centre on the "Life and Behaviour of Primary Batteries used for Telephone Purposes." The paper was of a highly interesting and instructive character, containing some of the results of five years' research work. Mr. Lucas has received appreciations from several quarters.

In January the Centre shifted its headquarters from the "Northampton" Institute to the premises of the Institution of Electrical Engineers, Savoy Place, Thames Embankment.

Every attention and courtesy had been paid the Committee of the Centre by the authorities of the "Northampton," but it was understood from the first that the accommodation there was only temporary, and that the true home of the Centre was at the "Parent" Institution.

At the Inaugural Meeting held at the Institution of Electrical Engineers on January 9th, and at which Messrs. A. M. Ogilvie and W. G. Gates, assistant secretaries to the Post Office, were present, Mr. L. J. Sell read a paper on "Testing Paper-Core Underground during Construction." Mr. Sell dealt with some of the difficulties encountered by an engineer in testing new cabling work.

The fifth Ordinary Meeting of the Centre was held on February 13th when the Secretary to the Post Office, Sir Matthew Nathan, was present. Mr. E. W. Pettit read a paper on "Conveying Systems," and gave some fine views of systems in use in certain American post offices. Mr. Pettit stated that the type of conveyor which more nearly meets the requirements of the Post Office than any of its rivals is the "band," and he gave full details of two conveyors of this type.

In the discussion which followed, Mr. H. C. Gunton stated that the attention of headquarters was already engaged on the subject, and that in future conveyors would probably be installed in offices suitable for the purpose.

Visits were paid to the Post Office Factories at Mount Pleasant and Holloway on February 1st and 8th respectively.

FAREWELL DINNER TO MR. E. CATLEY.

ON Friday evening, February 24th, a large company of the Metropolitan North District Engineering Staff entertained the

Superintending Engineer, Mr. E. Catley, and his assistant, Mr. J. Sinnott, to dinner.

The occasion marked the retirement on superannuation of Mr. Catley, and the promotion of Mr. Sinnott to Superintending Engineer of the North-Eastern District, Leeds. A capital musical programme followed, and during the evening the Chairman, Mr. J. R. M. Elliott, proposed the toast of "The Guests of the Evening." In a felicitous speech, interspersed with many humorous anecdotes, he recalled to the assembled company the outstanding characteristics of both guests, and, in wishing God-speed to Mr. Catley, he placed on record the loss of one of the most genial and impartial officers under whom it has been a pleasure to serve. Referring to Mr. Sinnott, he congratulated the North-Eastern District on gaining a superintending engineer who, whilst thoroughly practical, had also a kindliness of heart which had endeared him to all with whom he had been associated.

The toast was enthusiastically received with musical honours. Mr. Catley, in reply, was in a happy reminiscent mood, and after expressing his thanks to his staff for the loyal manner in which they had supported him during his term of office, he regaled them with anecdotes of his official career, in which mood he was later joined by Mr. Sinnott, who foreshadowed a greater future for the Engineering Department.

The remainder of the evening was given up to an excellent musical programme, "Auld Lang Syne" bringing to an end a thoroughly enjoyable evening.

WHIST DRIVE.

THE Engineering Department Chess Club held the second Whist Drive of the Season at Tiffin's, Cheapside, on Wednesday evening, February 1st. The attendance was not so large as at former whist drives, but over 100 persons were present and a very enjoyable evening was spent.

The social functions organised by the Chess Club are the only opportunities that officers from Headquarters and the Metropolitan districts and their wives and friends have of coming together to spend a pleasant evening. It is believed that they are greatly appreciated. The thanks of the Committee are due to all who support them.

THE O'MEARA CUP.

THE 1911 Competition took place during the first week in March, resulting in the Cup being again won by the Engineer-in-Chief's Department with a score of 574 out of a possible 600. Fourteen teams competed as against eleven last year, the scores on the whole being of a higher standard. The teams, consisting of eight men, six to count, with their scores, are as follows:

Engineer-in-Chief's Office:		
J. W. Laurence	98	
D. Reid	96	
W. Smith	96	
A. C. Smith	96	
E. J. Moller	95	
— Allman	93	574
H. Taylour	92	
F. Addey	92	
Northern District		572
Metropolitan North District		564
Metropolitan South District		560
South-West District, "A" Team		559
North-East District		547
Scotland East District		546
South-East District		542
North Wales District		542
South Wales District		539
South-West District, "B" Team		522
Eastern District		505
Central Exchange		497
Midland District		383

EASTERN CENTRE.

The third meeting of the Session was held at Cambridge on the afternoon of Tuesday, January 3rd, 1911, when a paper was read by Mr. T. Cobbe on "The Common Battery Telephone System." Practical illustrations of the system were given by the lecturer by means of apparatus specially loaned for the purpose. The paper was illustrated by some excellent diagrams. In view of the fact that there are no common battery exchanges in the district the paper was much appreciated and well discussed.

The fourth meeting took place on the afternoon of Tuesday, February 7th, 1911, when Mr. E. T. Titterington contributed a paper on "The Training of a Lineman." The lecturer enlarged on the varied and complex nature of the duties entrusted to linemen of the present day, and argued that in order to ensure the efficient performance of those duties a special system of training should be organised by the Department.

A very full discussion followed.

NORTH-EAST CENTRE.

The Annual Meeting of the North-East Centre was held on December 17th. Mr. Longden presided over a representative gathering of the members. The Annual Report (local) was read and a number of matters of general interest brought forward and discussed.

Following the meeting the Annual Staff Dinner took place at the Griffin Hotel, and advantage was taken of the opportunity to bid farewell to the late Superintending Engineer, G. M. Carr, Esq. After the usual loyal and official toasts had been duly honoured, the toast "Our Guest" was proposed by Mr. E. Catley in an able and appropriate speech, in the course of which he warmly eulogised the personal and official qualities of Mr. Carr, under whom he had served as Assistant Superintending Engineer for a number of years. The toast was supported by Messrs. J. D. Taylor, S. A. Pickering, and E. H. Farrand, after which Mr. Carr feelingly responded in a speech reminiscent of his fifty years of service, and containing much practical advice to the younger officers present.

During the evening an enjoyable programme was provided by the following gentlemen: Messrs. H. N. Ward, Farndale, Barratt, Armitage, Clayton, Butterfield, Elsworth, Lean, Barton, Jamieson. Mr. G. Crowe acted as accompanist throughout. On January 16th Mr. G. H. Hoole read a paper entitled "The Organisation of a Sectional Engineer's Office."

In the course of the paper it was clearly shown that under the arrangements now existing, engineers are burdened with a mass of work proper to be performed by clerical force, and it was urged that an augmented clerical staff in charge of a second-class clerk in the engineer's sections would result in higher efficiency, whilst setting the engineer free for work proper to his class.

On Monday, February 13th, following the visit described below, a very interesting paper was read by Mr. R. McBurnie on "Section Stocks: Theory, and Practice." Mr. McBurnie outlined the reasons underlying the Department's decision to close the district *depôts*, and described the method of accounting under the new system.

The thanks of the members are due to Mr. McBurnie for kindly stepping into the breach caused by the regretted illness of Mr. T. E. Herbert, for whom we wish a speedy recovery.

VISITS TO WORKS.

On February 13th, by the courtesy of the Directors and the Manager of Works, a party of twenty-four paid a most interesting visit to the Leeds Steel Works (Messrs. Walter Scott, Ltd.).

The various processes in the manufacture were explained by the gentlemen who acted as guides during the tour of inspection, and to these gentlemen the thanks of the members are due for a profitable and enjoyable afternoon.

NORTH-WESTERN CENTRE.

The third meeting of the Session was held at Manchester on December 5th, 1910. Mr. K. J. S. Gold read a paper on "Unit Maintenance Cost." There was a good attendance at the meeting, and considerable discussion followed the reading of the paper.

The fourth meeting was held at the Municipal School of Technology, Manchester, on January 16th. Mr. W. B. Smith read a paper on "Photo-Electric Effects, Selenium, and Photo-Telegraphy." The paper was illustrated by experiments and lantern-slides, all of which proved of great interest. A short discussion followed.

The fifth meeting was held at Manchester on February 6th. Mr. G. Bowyer read a paper on the "Maintenance of Switch Sections in Primary Battery Exchanges." The paper was illustrated with lantern-slides, which were very interesting. A short discussion followed.

On February 6th and 7th the members of this Centre visited Messrs. Connolly's Wire and Cable Works, Blackley Vale Mills, Blackley, Manchester. The visit proved of very great interest, and the members are very much indebted to Messrs. Connolly Bros. for their courtesy and hospitality.

Rifle Club.

A Rifle Club has been formed and range constructed. It has not yet been possible to have any rifle practice, as the range has yet to be inspected by the War Office authorities. When this has been done it is hoped that it will be possible to raise a team to compete for the "O'Meara Cup." The Hon. Secretary of the Club is Mr. J. F. Fletcher, Superintending Engineer's Office, 13, Quay Street, Manchester.

SCOTLAND EAST CENTRE.

A lecture on "General Submarine Work" was given by Mr. Machugh, Superintending Engineer, before an excellent attendance of members on December 14th, 1910. As is well-known, Mr. Machugh has had unique experience of this class of work in the north of Scotland. He dealt very fully with all stages of the work, illustrating with working models and diagrams the methods of cable laying and repair when only local boats and appliances are available, and also as carried out by the submarine staff of H.M.T.S. "Monarch" with a full complement of crew and fittings.

The lecture gave the members a good idea of the methods of dealing with submarine cables and faults thereon.

The diagrams were prepared by Messrs. Tyson and Lomax, of the Superintending Engineer's office, and the models of ship and boat by Mr. Laidlaw, storekeeper.

The fifth meeting of the Centre took place on January 11th, 1911, when Mr. John Patrick read a paper on "The Construction of Heavy Main Lines," Mr. Machugh presiding. The paper covered all the important features of main line construction, such as laying out of stores, economical disposition of gangs, prevention of interruptions on working circuits, tree cutting, provision for future development, and different methods of running wire. A demonstration with models was given of running and twisting in one operation four wires for telephone trunk purposes, which appeared to simplify the method recently introduced by the Department. Mr. Patrick pointed out that this arrangement had been suggested by Inspector Summerfield, and saved considerable time and labour over the usual procedure.

The lecture was illustrated by some sixty admirable lantern-slides, prepared and shown by Mr. Tyson, of the Superintending-Engineer's office.

The friends of Mr. A. J. McD. Murray, Sectional Engineer, Edinburgh, will regret to learn that he has been superannuated on account of ill-health, after twenty-eight years' service. Mr. Murray was extremely popular with all officers under his control, and those with whom he came in contact in other Departments in the service.

It is hoped that the rest from official duties will speedily restore him to a more satisfactory state of health.

SECOND ANNUAL WHIST DRIVE AND DANCE.

A very pleasant evening was spent by the staff and friends in the Carlton Hotel on Wednesday evening, December 14th, 1910. There were sixty-four ladies and gentlemen present. Mr. and Mrs. Machugh received the guests, and a whist drive was afterwards carried through, Mrs. Gill and Mr. Scouller winning the first prizes, and Misses Currie and McKenzie and Messrs Campbell and McInytre the second prizes. After refreshments had been partaken of a most enjoyable dance was taken part in by the Company. Interspersed between the dances, songs contributed by Miss Currie, Messrs. Machugh, Jefferyes, and Eadie, and a special dance by Miss Machugh were highly appreciated.

The success of the gathering was greatly due to the efforts of the committee, Messrs. Lomax, Miller, Scouller, and Walsh, to whom thanks are due ; as well as to Miss Neill, and Messrs. Gill and James Machugh for their services at the piano.

The sixth meeting of the Centre took place on March 8th, 1911, when Mr. Pym, of the Superintending Engineer's office, read a paper on "Accounting" before an excellent turn-out of members, Mr. Machugh presiding.

Mr. Pym dealt fully with the methods of pay-bill accounting, taking each step chronologically. A small pay-bill was compiled to represent a district account. The members were each presented with a copy of the model, which will no doubt be of great service for future reference.

The paper was very much appreciated by all present. It was practical, and will be of great benefit to those whose duties have not brought them experience in accounting.

SCOTLAND WEST CENTRE.

The second meeting of the Local Centre was held on December 8th, 1910, at which Mr. J. B. Laidlaw delivered a paper on the "Maintenance of Heavy Overhead Lines. The lecturer dealt specially with the stability of heavy trunk lines, making special reference to their condition after storm shocks. He pointed out that one man was quite incapable of doing much in the way of remedying such defects as (1) buckled poles, (2) poles over bodily, (3) stays slack, (4) wires out of regulation, and recommended that in place of the existing arrangement of having one lineman to deal with a particular length a small mobile gang, consisting of about three men, should be available in each section to deal with such defects. The use of a motor wagon for construction gangs was also dealt with at some length by the lecturer. A spirited discussion followed, in which the Superintending Engineer and several others members took part.

SOUTH WALES CENTRE.

Visit to Messrs. J. Lysaght & Co.'s Orb Ironworks, Newport.

By the courtesy of Messrs. Lysaght & Co., and under the guidance of Mr. Whitmore (engineer) and his assistants, about twenty-five of our members were conducted through the various departments of the Orb Ironworks at Newport on Tuesday, January 10th.

Furnaces, rolling mills, and shearing machines, tended by expert workmen and driven by a series of enormous engines, combined to evolve thin sheets of iron for galvanising and other purposes from steel sheet bars.

One of the most interesting items was the electrical plant for indicating at the engineer's office, located a quarter of a mile from the works, the heat in the various furnaces, thus enabling the controlling engineer to issue, by telephone, instructions for the regulation of the fires and dampers.

SOUND, LIGHT, AND HEAT.

Mr. J. H. M. Wakefield read a paper on "Sound, Light, and Heat" at a meeting held in the Engineer's Office at Newport on Tuesday, January 10th, under the chairmanship of Mr. T. Jenkyns.

The practical bearing of at least two of the three subdivisions of the paper upon the work of the Post Office engineer was very ingeniously worked out, and, aided by a selection of lantern diagrams, the lecturer provided a very interesting and instructive evening.

SECONDARY CELLS.

Mr. C. M. Herbert read a paper on "Secondary Cells" at Cardiff, on Tuesday, February 14th.

Owing to the pressure occasioned by "transfer" matters looming large on the District horizon, many members now find it difficult to attend meetings, but the discussion which followed the reading of Mr. Herbert's paper was proof of the interest which had been taken in the lecture by those who were able to be present on this occasion, and more than one debatable point was raised.

RETIREMENT OF MR. J. W. ROBINSON.

Our genial and esteemed Senior Engineer, Mr. J. W. Robinson, has retired and returned to his native air in the "North Countrie."

Mr. Robinson came from Llanfair relay station to the South Wales District as an engineer in 1892, but his service dated back to 1868, when he joined the Electric Telegraph Co.

In South Wales Mr. Robinson has seen several re-organisations, and he has been located both at Swansea and Newport.

On January 10th his colleagues and friends assembled at a smoking concert to wish him many years of peaceful retirement in his new home at Scarborough, with his family, his pipe and his camera.

METROPOLITAN CENTRAL BENEVOLENT SOCIETY.

Two and a half years ago the idea was conceived of forming a local benevolent society in order to relieve cases of distress which unfortunately occur amongst all large bodies of men. The Society was formed in July, 1908, with a membership of 720. So far 130 grants have been made to members or to their relatives as under: Death of members, 9; deaths in the families of members, 26; sickness of members, 37; sickness in the families of members, 58.

The following will illustrate the cases relieved:

(1) A member on sick leave was advised by his medical attendant to go to a sanatorium. The period of sick pay allowed had expired, and the man's wife and children were left without provision. The Society awarded a grant of 15s. for eight weeks.

(2) A young man had to retire from the service owing to ill-health. The sick-pay limit had been reached, and before the small pension was authorised the man, his wife, and two young children were practically destitute. A grant of £2 10s. was made, together with a further grant of £1 per week for five weeks.

(3) A member resigned from the Department's service, and subsequently disappeared, leaving his wife and three children penniless. The Society awarded a grant of £1 a week for five weeks.

(4) A member was absent from duty for two months owing to an accident. He received half-pay only from the Department. An award of £2 was made.

The Society now contributes 15 guineas a year to the Hospital Saturday Fund. As a result of this contribution, forty hospital orders have been obtained. Also orders for dental treatment, and one order for a member to enter a sanatorium.

Each member of the Society contributes one penny a week.

There is a central committee of management. Each section of the district has a local committee consisting of three members, who make a thorough investigation into the merits of each case, and who forward particulars with their recommendations to the central committee of management.

Committee meetings are held every two or three weeks after official hours.

The duty of collecting the weekly subscriptions in each section is performed by the local representative on the central committee. The success of the Society is due largely to the voluntary efforts of these officers who devote their own time not only to committee meetings, but also in undertaking the duty of collecting pennies in the sections from between 50 to 130 members weekly. The members are widely scattered, and this fact entails a considerable amount of work. The efforts of these officers deserve special commendation. The present balance in hand is £35, and the membership 760.

The superintending engineer, Mr. W. Noble, is the president.

Mr. John Hardie, Sectional Engineer, has acted as chairman of the central committee since the inauguration of the society, and he has devoted much of his own time to the interest of the society. Mr. J. T. Langley, engineer, has worked hard in co-operation with Mr. Hardie, and Mr. J. Smerdon is an enthusiastic secretary.

Since the formation of the society the "sending round of the hat" has been dispensed with in the Metropolitan Central District, and much good has been accomplished.

It is understood that a society, on somewhat similar lines, has existed for many years in the Midland District; and perhaps other districts may decide to establish similar local benevolent societies.

A. E. COOKE.

BOOKS RECEIVED.

'Practical Wireless Slide Rule,' by Dr. H. R. Belcher-Hickman. (London: 'Electrician' Printing and Publishing Co. 2*s.* 6*d.*)

The computation of wave-lengths and frequencies in radio telegraph engineering work and investigations, from given electrical dimensions of oscillatory circuits and systems, or the reverse operation of computing electrical dimensions from wave-lengths observed, even with the assistance of the ordinary mathematical slide rule, becomes a tedious undertaking when many independent calculations are required. For work of this kind engineers and investigators will therefore welcome the appearance of this handy little device in the shape of a card slide rule specially arranged for such calculations. A range of wave-lengths from 100 to 10,000 metres, and the corresponding frequencies, are covered so that the ordinary practical requirements are fully met. Wave-length scales in feet and metres are provided. Capacity, marked C (Why not K?), is in separate scales of electro-magnetic and electrostatic units, whilst L is given in electro-magnetic units. The use of the rule is a little complicated by reason of the double pointer necessary to extend the range of the scale and the multiple units adopted in the lower scales, and a little practice is necessary to ensure accuracy in manipulation or interpretation of the readings, but this is inherent to the nature of the computations to be made and the desirability of retaining reasonable size of rule.

Full working instructions and a compendium of useful information germane to the subject are given in condensed form on the reverse side of the appliance. Being put together on stout cardboard, the rule is, perhaps, less suited for the pocket than the desk, but is sufficiently robust to withstand a reasonable amount of fair wear and tear.

'The Practical Electrician's Pocket-Book and Diary, 1911.' Pp. 300, illustrated. (Rentell & Co. 1*s.* cloth, 1*s.* 6*d.* leather, net.)

The different distinct branches of electrical work are to-day so numerous, and their ramifications so extensive, that the practical utility of a concise up-to-date statement of approved practice in respect to the many subjects cognate to an electrician's daily work needs no justification. Such a review, written for the most part by experts in the particular branches of the subjects dealt with, is contained in this handy annual, which has been enlarged, revised, and its sphere of usefulness still further widened.

The current issue contains several improvements on last year's edition. Much valuable matter has been included in the sections on conduit and wiring systems, whilst the complex question of the winding, testing, and repair of armatures is clearly handled. The chapters on boilers, gas, oil and steam engines and turbines furnish a carefully revised statement of present-day practice, whilst the question of the choice of motive power under varying conditions is a concise and handy statement of the elements of the problem. The contributions on main and sub-station switchboards, arc lighting and safety devices are critically written, and are well illustrated. The distinctive wants of wiremen and installation attendants are catered for in the practical hints on secondary batteries, dynamos, alternators, lubrication, rheostat troubles, meters, and testing instruments. A handy section on electric impulse clocks is included, but why the chapter on condensers has been omitted it is difficult to say. The increasing use of condensers, choking coils, etc., certainly warrants treatment in a pocket-book of this kind. The telephonic information included, too, is meagre in the extreme, certainly not in consonance with the vast importance of the subject, whilst the various systems of telegraphy are omitted altogether.

Additional particulars are supplied in the list of central stations, but even yet important modifications as to unit charges are omitted, which in many cases renders the information supplied unreliable. The 'Pocket-book,' nevertheless, is an extremely handy one, and to members of the engineering profession engaged in Post Office work well worth a place on the shelves of the reference library.

'Telegraphist's and Telephonist's Notebook.' Pp. 120. (S. Rentell & Co. 1*s.* 6*d.* net.

The purpose of the author in this notebook is to present in a concise and practical form information frequently required by the employees of the telegraph, telephone, and railway services, but whilst much useful data is contained we cannot congratulate the author upon either its arrangement or its completeness. It is difficult to understand why the chapter on primary batteries should be separated from the chapter on secondary batteries by chapters on the magnetic circuit and Ohm's law, or why the table of substances, with their symbols and atomic weights, should be carefully separated by a hundred pages from further tables of data on the metallic elements.

The paucity of diagrams, too, is a grave defect. A diagram would frequently render perfectly plain many of the tests which the author is at pains to explain at length. Many of the chapters contain, nevertheless, much useful information as to present-day practice. The Kotyra, Gell, and Yetman systems are briefly noticed, although no mention is made of the Creed apparatus. The chapters on relays, galvos, and the shunted condenser show an inside acquaintance with the subject, and the section on units and standards is useful though not very concise.

The omissions are noticeable and unjustifiable. The section on "Construction" has entirely overlooked underground work; no mention of the Megger appears in the notes on testing apparatus; a brief reference to polarised sounders on page 45 is the only acknowledgment of the growing importance of C.B. telegraph systems; superimposed telegraphs appear to have been forgotten, as have also testboards, concentration arrangements, and wireless systems.

Telephony, too, receives scant treatment, and such meagre notes as are included are far from up-to-date. The Hunnings cone transmitter is described and illustrated, but the modern solid-back type is not mentioned. The C.B. system is so briefly treated as to be of no practical value, whilst the C.B.S. systems, junction working, and the essential equipment of the modern telephone exchange are ignored.

'Practical Telephony' (5th edition), by Bell and Wilson. (3*s.* 6*d.* net).

The fifth edition comprises 300 pages and over 230 illustrations. Changes in telephonic practice have been so numerous during the last few years that the fourth edition had to be rearranged and the greater part of it re-written. Reference is made to the latest trunk and local telephone systems.

It is our reluctant duty to direct attention to some passages which need revision.

Page 31 contains the following statement respecting the action of an induction coil: "If a current is already flowing in the primary circuit and it is suddenly *increased*, a current will flow in the same direction as the former, and when the current is *decreased* a current will flow in the same direction as the latter."

A "supplementary resistance of 55 ohms" is referred to on page 83. Unless this is a new term for the transmitter of the operator's telephone circuit we cannot reconcile the statement with the diagram.

In describing the action of the time check on page 133 terms are used which apparently refer to an omitted diagram or drawing, *e. g.*, "contact arm CA," toothed wheel W," "platform C."

The authors are to be congratulated on the clearness of the illustrations.

J. W. WOODS.

Mr. J. W. Woods, Assistant Engineer-in-Chief, retired from active service on January 14th last, after a period of forty-five years spent principally in the engineering service.

Mr. Woods entered the service of the United Kingdom Telegraph Company on January 14th, 1866, and, on the transfer of the Telegraphs from the old companies to the Post Office on January 29th, 1870, was stationed at Oxford. He acted for a time as clerk to the late Mr. George Blewitt, Engineering Superintendent, and afterwards became an inspector. It was at

Oxford that his tastes were first directed to electrical problems, and his studies were very assiduous, resulting in his being selected by the Science and Art Department as a teacher at Oxford. He also acted as demonstrator to the late Professor Lant Carpenter for two sessions.

In 1891 Mr. Woods was appointed Assistant Superintending Engineer of the South Midland District, with headquarters at Birmingham. In February, 1897, on the retirement of Mr. F. E. Evans, Mr. Woods was promoted to be Superintending Engineer at Birmingham.

In connection with the telephoning of London three engineering districts were formed, and Mr. Woods was appointed in 1901 to be Superintending Engineer of the central area. This area included the Central Telegraph Office, the Stock Exchange, the Central and Trunk Exchanges, also the Mayfair and Victoria Exchanges. The work of organising the telephone system was very strenuous, but with the aid of a hard-working and loyal staff the huge telephone schemes were successfully carried out.

In May, 1907, Mr. Woods was appointed to the important position of an Assistant Engineer-in-Chief at St. Martin's-le-Grand.

Mr. Woods was appointed to serve on the "Advisory Board," and in consequence was brought in touch with many sectional engineers. Bearing in mind his duty to the Department and to the engineers concerned, he felt the responsibility of this duty very keenly, and it was a source of regret to him to have to report that an officer did not reach the present-day standard of qualifications and efficiency.

During his long service Mr. Woods has taken part in many changes and improvements in the working of the telegraph and telephone systems. He had a keen grasp of electrical subjects, and his engineering knowledge was of the eminently practical order. Some well remember him twenty-six or twenty-seven years ago, when he had charge of the Oxford section. During snowstorms which occurred, when poles and wires were broken, Mr. Woods was one of the first on the scene of action to assist his men through trying circumstances. His manner was kindly, and he inspired his subordinates to put forth their best efforts. He knew a good worker, and trusted him.

Mr. Woods was a believer in physical as well as mental exercise. For over thirty-five years he has been an ardent cyclist. He has also taken a keen interest in the gymnasium. He appears to be in robust health, and considers that every officer should retire at the age of sixty.

It is understood that he and Mrs. Woods intend to travel on the Continent and to the United States before settling down to a quiet life.

We wish him every happiness, and trust that he will be spared to live long and enjoy his well-earned rest from official cares and responsibilities.

A. E. C.

W. SLINGO.

We publish in this issue a copy of the photograph of the Engineering Staff of the North Wales District taken on the occasion of Mr. W. Slingo's recent promotion, and to commemorate his seven years of office as Superintending Engineer of that district.

Mr. Slingo's official career opened in the Central Telegraph Office on June 25th, 1870. In 1898, on the closing of the Telegraphists' School of Science, he joined the staff of the Engineer-in-Chief as Technical Officer (first class). In the meantime, both in his official capacity and otherwise, his keen and active interest in the natural sciences in the palmy days of Tyndall and Huxley marked him out for early distinction, and it is sufficient to recall the extraordinary success of the Telegraphists' School of Science under his guidance and care, and the world-wide reputation which Slingo and Brooker's 'Electrical Engineering' still enjoys in its thirtieth thousand, to indicate the solid and enduring character of his scientific and technical achievements.

In January, 1904, Mr. Slingo moved to Liverpool to take up the post of Superintending Engineer of the North Wales District. Unhampered by any of the traditions of the older school, and equipped for his work by a wide technical and departmental experience, he struck at once a high and individual note. He had one standard at which he constantly aimed—*the best;* and his keen and shrewd critical judgment and knowledge of men exercised itself not in the merely destructive criticism of error and defect, but carried with it the rare faculty of evoking the best that was within others, and stimulating and guiding an interest which matured into a genuine enthusiasm for efficiency and order.

Now that a quiet review can be taken of Mr. Slingo's seven years' work in the North Wales District, it is placed on record by those among whom he moved that his work as a superintending engineer was carried out with extraordinary ability and success; and the best testimony to the nature of the personal demand, which he coupled with his insistence everywhere, and always upon efficiency, is to be found in the warm regard and esteem spontaneously expressed by officers of all ranks on his departure from Liverpool to take up work as Assistant Engineer-in-Chief on the inventory of the National Telephone Co.'s plant.

Perhaps in nothing was Mr. Slingo's success greater or of a higher order than in his treatment of stubborn wayleave questions. On his advent in Liverpool wayleave problems existed which had continued for so many years that they had come to be regarded as evils to be endured rather than removed. On his departure none of these cases remained outstanding, many potential difficulties had been surmounted, and well-set-up lines now stand along many a road which under ordinary circumstances had been regarded as absolutely closed to works of this description. These results were achieved withal without any aftermath of resentment or obstruction, and it is not going beyond the warrant of the facts to say that everywhere, despite the successful issue to which Mr. Slingo invariably brought his wayleave troubles, the Department's relations with road authorities and landowners are on an entirely satisfactory footing.

He has left at Liverpool a tradition which will not quickly pass away, and his late staff rejoice in the recognition which his abilities and personal qualities have received.

H. HARTNELL.

By the retirement of Mr. H. Hartnell, at the age-limit of sixty-five years, the Engineer-in-Chief's office loses one of its ablest officers, and his colleagues one of their best personal friends. Born in the year 1846, a native of Somerset, Mr. Hartnell in his education at Axminster received a grounding which proved invaluable to him when he had, unaided, to carry on the studies which he made such good use of, and which brought him eventually to the position of Staff Engineer at Headquarters, where, it is perhaps needless to say, he did work of the very greatest value to the Department. Practically Mr. Hartnell commenced his official career as a telegraph learner at the Taunton office of the Bristol and Exeter Railway, where he spent three months practising double- and single-needle working, the latter being at that period comparatively a new system.

Having passed the learner stage Mr. Hartnell was transferred to Yeovil, where there was one single-needle circuit, used chiefly in signalling trains and for some messages, a few public messages being also transmitted on behalf of the old "Electric and International" Co. It is interesting to note that the rates at that remote period were practically prohibitive, these rates ranging for a telegram from Yeovil to Leeds, for example, from 4s., to 8s. for a message to Scotland or Ireland; the public, in fact, were simply scared by the sight of a telegram, feeling that nothing short of death or a dangerous illness could be the cause of its being sent.

From Yeovil Mr. Hartnell proceeded to Cardiff and thence to Bridgend, where he was put in charge of the telegraph there, which occupied one corner of the booking-office; there was only one circuit with ten offices connected, Cardiff and Milford Haven being the terminals; the fights for "code turn" and the consequent delays which took place can be imagined. From Bridgend Mr. Hartnell was transferred to Port Talbot, thence to Cardiff, Kidderminster, Bristol, and Pembroke Dock, where he was stationed in 1870 when the transfer of the telegraphs to the State took place. This latter event resulted in Mr. Hartnell's hours of duty being considerably increased —from twelve to fourteen (7 a.m. to 9 p.m.) per day. At Cardiff, however, to which he was transferred, the work hours were somewhat lighter, and subsequently to Carmarthen, and then to Hull, where there were plenty of opportunities of his exercising his linguistic knowledge (which was of a high order), as a large number of messages dealt with there were in Swedish, Danish, German, and even Russian.

From Hull Mr. Hartnell proceeded to Nottingham, at which town he was located for over ten years. In 1880 he gained the first prize and silver medal in the City and Guilds examination in telegraphy, and as a result was nominated to compete for the post of Technical Officer in the Engineer-in-Chief's office. The examination was conducted by the Civil Service Commissioners and lasted a week. As might be expected, no other competitor was able to make headway against Mr. Hartnell. As a consequence he took up duty in London in September, 1884, where he remained until his retirement.

Of Mr. Hartnell's services during the twenty-seven years he worked at the Engineer-in-Chief's office it is perhaps unnecessary to say much, as they are well known and highly appreciated. There was scarcely any class of work in which he was not more or less closely in touch, and the benefit of his ripe experience was constantly sought. As the head of the "Examinations" Section he had a large staff to control and very responsible duties to perform. Not only did these duties relate to the examination of physical bodies, but also to the examination of members of the Commercial Staff for double increments and for promotion; for although this work was not normally part of the work of the "Examinations" Section, yet it was recognised that Mr. Hartnell was particularly qualified for the task in view of his sound knowledge and tactful character. Mr. Hartnell's knowledge of all matters in connection with cable (both submarine and underground) construction was extensive and thorough, and the mileage which passed under his personal observation reached an astonishing figure; indeed, his knowledge in this respect resulted in his being appointed a member of the Standards Committee. During his career Mr. Hartnell took many honours in the shape of prizes in various subjects, and had circumstances permitted there can be no doubt but that he would have obtained a science degree without difficulty, but extreme and continual pressure of official work allowed no time for the necessary study.

Although Mr. Hartnell no longer forms one of the existing staff, the glamour of his presence still remains and will continue to do so. We wish him health and happiness in his retirement.

G. M. CARR.

In April, 1857, Mr. Carr joined the service of the Electrical and International Telegraph Co. He soon became proficient in manipulation, and in the following year was appointed to a railway station, where his salary and services were divided between telegraph and railway work. The former took precedence, but as the railway work largely predominated Mr. Carr obtained valuable experience in general clerical duties, to which he attributes much of his success in later life.

At the time of Mr. Carr's entry into the service the company had, after many vicissitudes, attained a much more secure position as a business concern. Rival companies had already begun to seek a share of the success due to the new means of communication.

The old double needle of the Cooke and Wheatstone still predominated, but was gradually giving way before the more economical Morse and single needle. It is noteworthy, however, that whilst the period under review might be called a day of small things, there were many evidences of progress and unwillingness to rest content with present attainments. Several submarine cables had already been laid. The first Atlantic cable was in process of manufacture, and was laid in 1858. Ruhmkorff had completed his induction coil, an apparatus destined to play a part fifty years later far beyond the dreams of its maker in connection with wireless telegraphy and X rays.

Cromwell Varley had shown the value of low-resistance batteries on leaky lines. Double-current translators were in daily use. Duplex telegraphy had been demonstrated, and only awaited a demand, which did not arrive for some years.

Circumstances led to Mr. Carr being stationed in no less than ten different towns in the first seven years of his career, including Manchester and Birmingham. He thus gained an experience which he was able to turn to good account.

In 1863 he joined the service of the United Kingdom Telegraph Company, the pioneers of cheap telegraphy, who sought to establish a uniform shilling rate. The apparatus used by the company consisted of Siemens-Halske single-current Morse inkers, fitted with Siemens relays. On several important wires the Hughes instrument was employed, and on the omnibus lines the American closed-circuit Morse with batteries at the terminal stations only was in operation. These latter circuits, in ordinary weather, were very effective, and were believed to be instrumental in furnishing the Company with good class operators. Each sender heard his own signals. Learners became proficient in minimum time.

In wet weather, with low insulation, it was no uncommon thing for a distant station to be calling on these circuits without the slightest sign, even on the galvanometer needle at the distant end, until the adjustment was altered, when perfect signals would be at once observed. Thus it not infrequently happened, during prolonged wet weather, that operators at both terminal stations were working to a near station at the same time on the same wire.

Mr. Carr recalls watching for the first testing signal over the Company's newly erected open line between Leeds and Newcastle-on-Tyne, and forty-six years later, as Superintending Engineer of the North-Eastern District, laying a large instalment of the long-distance underground pipe between the same points.

As the Company's lines extended northwards Mr. Carr was prominent in opening new offices, advertising the Company's intentions, canvassing for customers, and other work.

When the telegraph transfer took place in 1870 his facility in dealing with indoor engineering attracted attention, and he was attached to the Engineering Branch.

Mr. Carr was actively engaged with the introduction of the telephone, and under Mr. A. W. Heaviside, Superintending Engineer, opened the first Post Office Exchange in 1881. Untried apparatus, unforeseen troubles, and the large expectations of the public created a difficult situation, which required great patience and strenuous application until matters reached a more stable condition.

In 1892 Mr. Carr was appointed Assistant Superintending Engineer, and in 1896, on the eve of the transfer of the Trunk wires, he was appointed Superintending Engineer of the North Eastern District; headquarters, Leeds.

Mr. Carr soon made his personality felt. One of the most important questions he had to face was the preservation and extension of open lines for telephone trunk circuits in towns, and his masterly handling of several difficult wayleave cases with different Corporations has left an indelible mark on the district; and it is fair to say that the cogent and far-reaching arguments he personally then placed before city and town councils paved the way for the cordial relations which now exist between the Post Office and the road authorities in the North Eastern Engineering District.

Another of Mr. Carr's notable activities was in connection with faults—not only in organising for their prompt removal, but, what is equally important, in preventing them. He always took a keen interest in this matter, and his efforts have resulted in a great diminution of faults of every kind in the district.

He gave much consideration to the question of accounting for stores used by gangs, and finally designed the present system of daily stores sheets, which keeps a rigid check on all stores used.

Mr. Carr realised early that some method of arriving at the comparative costs of the maintenance of the various items of plant was necessary. The present system of unit maintenance costs in principle is identical with that prepared by Mr. Carr, and laid before the Engineer-in-Chief in 1904.

He evolved an efficient system of ascertaining unit construction costs. He was the first to deal effectively with the standardisation of linemen's loads and rota duties.

He has taken a life-long interest in aërial line construction, the effects of snow and ice loads on the wires, and is a firm believer in the possible and ultimate avoidance of the serious dislocation of traffic due to this cause.

Mr. Carr was selected to serve on several committees formed to investigate questions affecting the Engineering Department. He has been connected with the Institute of Electrical Engineers since its formation in 1871, and served on the committee of the Yorkshire local section of that body. He was also entrusted by the late Engineer-in-Chief, Sir John Gavey, with the Chairmanship of the Board formed to place the Institute of Post Office Engineers on a proper footing.

His two outstanding characteristics are thoroughness and pertinacity, and these gave him an extraordinary knowledge of detail.

He was "guest of the evening" at the annual dinner of the Engineering Department (North-Eastern District) in December, 1910, at which function every rank of officer in the district was represented.

Mr. Carr will have, in his retirement, the best wishes of all who served under him.

Although his service dates from 1857, and probably is very nearly a record for length in the Civil Service, he has still a store of energy left, and has been placed—along with other officers who have been drawn from retirement—in charge of one of the inventory checking groups.

OBITUARY.

JOHN IRVING MITCHELL.

[Owing to lack of space it was not possible to include this in our January number.—ED.]

IT is with great regret that we have to record an occurrence, fortunately very rare in our service—the death of a skilled lineman through an accident on duty, under circumstances of a peculiarly distressing character.

John Irving Mitchell, aged 35, who for sixteen years had been stationed at Tebay, and had proved himself a remarkably active and efficient officer, was transferred on October 7th last to Kendal. Three days later he cycled over one of his lines, returned to Kendal about 4 p.m., called on his way through the town to see his wife (who was busy preparing their new home) and proceeded to the Post Office.

From that time nothing definite can be ascertained, but he had apparently made up his mind to utilise his time in examining insulators and binders on an over-house section, and was seen at 4.30 p.m. to ascend the pole-steps on a 55-foot pole in a school playground.

About ten minutes later he was seen lying on the ground, and the alarm being given, a doctor was in attendance within a few minutes, but found the unfortunate man injured so as to be beyond all hope.

Mitchell's elder brother (also a lineman at Kendal) was attracted to the spot and informed that a "telephone man had met with an accident." Making his way forward to give any assistance in his power, the discovery he made must have been terrible.

The removal to hospital was effected promptly, but Mitchell passed away after lingering unconscious for about two and a half hours.

The injuries received were of a dreadful nature, the skull being fractured and the left shoulder and arm shattered, and there can be little doubt that he had fallen from the height of the arms—nearly fifty feet.

The pole carries six 96-inch arms, fitted with combiners in the usual way, and the two lowest arms are "spare" on the side from which he fell. Nothing can be definitely stated as to what work he was actually engaged upon, nor is anything known as to the cause of his fall. It is possible that he may have received a sudden shock from a generator, ringing on one of the trunk circuits, and that for an instant it caused him to lose his grip at the critical moment of passing from the arms to the pole-steps.

Mitchell was an expert climber with or without "climbers" on, thoroughly accustomed to work on high poles, fearless, strong, and wiry, and could go up a stay-wire with ease. That he lived for two and a half hours after the fall would appear to discount any theory of heart failure, and in view of the remarkable "nerve" and robust health possessed by Mitchell it is unlikely that he turned giddy.

It has been mentioned that Mitchell's elder brother is a lineman; their father also followed the same vocation, having been in the service of the old Magnetic Company at Kendal from very early days. He retired from the service of the Department after a long spell of active work.

T. H. N.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Slingo, W.	Asst. Engr.-in-Chf.	C. T. O., '70; Asst. Super., '90; 1st Cl. Tech. Officer, Eng'g. Dept., '98; Suptg. Eng., '03.
,,	Turner, L. B.	Staff Engr., 2nd Cl.	—
,,	Kerr, W. H.	Princ. Clk. Engr.-in-Chf.'s Office	Tel. Edinburgh, '89; Jr. Clk. Eng'g. Dept., '96; 3rd Cl. Clk., E.-in-C.O., '98; 2nd Cl., '00; 1st Cl., '07.
,,	Shepperd, A. H.	Clk., 1st Class, Engr.-in-Chf.'s Office	Tel. Belfast, '90; Jr. Clk. Eng'g. Dept., '93; 3rd Cl. Clk., E.-in-C.O., '98; 2nd Cl., '04.
,,	Whibley, E. J.	Clk., 1st Class	Tel., C.T.O., '84; Jr. Clk., 2nd Cl., Eng'g. Dept., '91; Jr. Clk., 1st Cl., '95; Jr. Clk., '97; 3rd Cl. Clk., E.-in-C.O., '99; 2nd Cl. Clk., '05.
,,	Few, H. P.	,, 2nd ,,	C. C. & T., L. P. S., '93; Clk., 3rd Cl. Eng'g. Dept., '02.
,,	Young, A.	,, ,,	Asst. Clk. Eng'g. Dept., '98; 2nd Cl. Examiner, Stores Dept., '99; Clk., 3rd Cl., Eng'g. Dept., '03.
,,	Gold, R. J. S.	,, ,,	Asst. Clk., S. B. D., '98; 2nd Cl. Examiner, Stores Dept., '00; 3rd Cl. Clk., Eng'g. Dept., '03.
,,	Eldridge, E. J.	Supertg. Engr.	1881; Jr. Clk., Eng'g. Dept., '87; Engr., 2nd Cl., '92; Tech. Officer, 2nd Cl., '03; Asst. Suptg. Engr., '05; Staff Engr., 1st Cl., '09.
,,	Trezise, J. M. G.	,, ,,	Engr., 2nd Cl., '97; 1st Cl., '98; Tech. Officer, 2nd Cl., '02; Asst. Super. Engr., '08; Staff Engr., 1st Cl., '09.
,,	Plummer, T.	,, ,,	Jr. Clk., '85; Engr., 2nd Cl., '93; 1st Cl., '97; Tech. Officer, 2nd Cl., '00; Asst. Super. Engr., '06.
,,	Tandy, F.	,, ,,	1885; Relay Clk., Eng'g. Dept., '91; Engr., 2nd Cl., '94; 1st Cl., '98; Tech. Officer, 2nd Cl., '02; Asst. Super. Engr., '06.
,,	Sinnott, J.	,, ,,	1884; Relay Clk., '91; Engr., 2nd Cl., '96; 1st Cl., '01; Tech. Officer, 2nd Cl., '02; Asst. Super. Engr., '07.
,,	Webber, Capt. O. T. O'K., R.E.	Asst. Supertg. Engr.	S. District, 1903.
,,	Bailey, F. H.	Engr., 1st Class	1880; Test Clk., T. S. D., '99; Eng'g. Dept., '03; 1st Cl., '04.
,,	Hutchons, E. R.	Engr., 2nd Class	4th Navg. Officer, '07; 3rd Navg. Officer, '08.
,,	Gravill, W. E.	,, ,,	1893; Jr. Clk., Eng'g. Dept., '02; Sub-Engr., '04.
,,	Hartnell, C. H. B.	,, ,,	Sub-Engr., '04.
,,	Anderson, J.	,, ,,	,, ,,
,,	Yule, J.	,, ,,	,, ,,
,,	Gilbert, D. P.	,, ,,	,, ,,

STAFF CHANGES.

RETIREMENTS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Woods, J. W.	Asst. E.-in-Chief.	U.K. Tel. Co., '66; G.P.O., '70; Asst.-Suptg. Engr., '92; Suptg. Engr., '97; Asst. Engr.-in-Chief, '07.
,,	Catley, E.	Suptg. Engr.	E. Tel. Co., '67; G.P.O., '70; Insp. Eng'g. Dept., '81; Asst. Suptg. Engr., '95; Tech. Offr., 1st Cl., '04; Suptg. Eng., '07.
,,	Hartnell, H.	Staff Engr., 1st Cl.	E. Tel. Co. 62; G.P.O., '70; Eng'g. Dept., '84; Staff Engr., 1st Cl., '98.
,,	Murray, A. J. McD.	Engr., 1st Cl.	Tel. Glasgow, '84; Jr. Clk. Eng'g. Dept., '84; Engr., 2nd Cl., '93; 1st Cl., '02.
,,	Robinson, J. W.	,, ,,	E. Tel. Co., '68; G.P.O., '70; Eng'g. Dept., '85; Engr., 2nd Cl., '92; 1st Cl., '01.
,,	Waddell, J.	3rd Engr. Officer, Cableships.	1893.
,,	Mosen, F. H.	Clk., 3rd Cl., Suptg. Engr.'s Office.	1900; Jr. Clk. (L.), '04.

DEATH.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept., Manchester.	Harrison, T.	Clk., 3rd Cl., Suptg. Engr.'s Office.	1895; S. C. & T., Manchester, '99; 3rd Cl. Clk., '07.

TRANSFERS.

Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Anson, B. O.	2nd Cl. Engr.	Met. C.		E. in C.O.	1 : 1 : 11
Baxter, E. H.	,,	E. in C.O.		Met. N.	8 : 12 : 10
Jolley, L. B. W.	,,	N.E.		E. in C.O.	1 : 1 : 11
Lawson, C. G.	,,	E.L. & P.		Met. N.	1 : 1 : 11
Lawson, C. G.	,,	Met. N.		E.L. & P.	15 : 2 : 11
Perrin, E. S.	,,	Met. S.		E. in C.O.	8 : 1 : 11
Reid, F.	,,	E.L. & P.		N.E.	8 : 1 : 11
Rivers-Moore, H.R.	,,	Met. N.		E. in C.O.	13 : 12 : 10
Vaughan, G. H.	Sub-Engr.	E. in C.O.		Met. C.	15 : 12 : 10
Timson, J. R.	2nd Cl. Clk.	Met. N.		E.L. & P.	9 : 2 : 11
Walsh, R.	3rd Cl. Clk.	Sc.E.		N.E.	19 : 2 : 11

COMMUNICATIONS.

ALL Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

Photo. by L. E. Caine.

NAIROBI (BRITISH EAST AFRICA) POST OFFICE.

See page 117.

THE
Post Office Electrical Engineers' Journal

TELEPHONES IN ENGLAND AND THE U.S.A.

By T. F. Purves.

The compilation of a voluminous official report goes a long way towards extinguishing any desire one might have to descant upon the subject-matter it deals with, and recollections of even the very interesting experiences which Messrs. Martin, Lee, Jones and myself recently enjoyed in the United States and Canada appear to have lost much of their zest and freshness after being subjected to the laborious process of hammering out on the official anvil. But the Managing Editor of this journal is a masterful person, and against his imperious demand for copy it is useless to attempt a stand.

Much of our report is, of course, of a confidential nature, containing too much, both of confession and criticism, to make any general publication desirable, and still more of it is taken up with dry details, which can hardly be of much interest to the general reader, and may be left for the delectation of those truly unfortunate individuals whose duty it will be to sift them for possible grains of wheat.

I am glad to know, however, that our visit to America is likely to be the precursor of a system of more frequent interchange of experiences in the same personal way, and in both directions, between officers of the Post Office and the great telephone and telegraph companies of the United States.

So far as telephones at least are concerned, we in this country have always freely admitted the immense contributions to the development of the art which have come to us from across the Atlantic. America was the cradle of the telephone, and has been, from the first, peculiarly its home. Its telephone engineers have led the world. The multiple switchboard, which first enabled large numbers of lines to be handled in one exchange, the common battery lamp signalling system, which greatly improved the service and reduced its working costs, and the automatic or machine systems of telephony, which aim at the elimination of the human agency of the operator, are all the product of American brains, and many of the original and most notable pioneers of these developments are still in active and responsible control.

So we have no kind of diffidence in seeking information from the Americans or in copying anything in their practice that will suit the conditions of this country.

But I would not give all the credit for the wonderful development which has scattered eight millions of telephones up and down the United States to their engineers and commercial managers. The American public has taken to the telephone as a duck takes to water, and its insistent demand has been a continuous spur to those in whose hands the provision of the service has rested. Its progress has been greatly helped by the absence of many of the facilities for cheap and rapid postal and telegraph communication, to which we on this side are so accustomed that we have ceased to notice them. The post is uncertain, and in country districts people have sometimes to travel a long way to post or obtain their letters. It is slow compared with ours, especially for internal city communications. The telegraph has been costly and poorly developed. Even at the present day there is a vast rural community which it does not serve at all.

I think the tendency to the erection of tremendously high buildings in American cities has also helped the telephone. When a man's office is perched, it may be, on the twentieth or thirtieth floor, he wants to do as much business as possible without going outside, and the telephone is a *sine quâ non.* With its help, by the way, I think the American is justified in looking upon the skyscraper as a very fine proposition. It permits of the concentration of a big business community in a wonderfully small area and under very pleasant and convenient conditions. One can well imagine the occupant of a dim and dusty London office, with a noisy street outside, looking with longing upon the thousands of splendidly situated office suites in down-town New York, where, in spite of the unheard-of density of the day population, one can have a room right away up in the clear, far above the noise and the dust and the flies, with pure air blowing in through the window and a wide panorama of land and water stretching outside it. I really believe London would be a much finer place, and hold its millions more conveniently too, if the streets were twice as wide and the buildings three times as high.

But outside these considerations I think the telephone is better suited to American business methods than to English. The American makes important contracts by word of mouth and is quite contented to do much of his business by telephone. He has recognised it as the greatest time-saver ever invented, and as a business-bringer that he cannot afford to be without either in his office or his private house. Consequently he sees that he gets it, and he doesn't mind paying for it. When the same attitude becomes general on this side of the water we are not likely to hear so much of England's backwardness in telephone development.

The telephone companies of the United States are, at the present time, divided into two great camps—the " Bell " companies and the "Independent" companies. The former group represents the companies formed to work the system under the patents of Mr. Graham Bell, the acknowledged father of telephony. There are between thirty and forty such local Bell companies covering the whole of the country, and they are now gathered into an aggregate of partially autonomous units under the general guidance and control of the American Telephone and Telegraph Co., which also owns and works in its own name a huge network of long-distance lines connecting up the various local companies and providing them with inter-communication up to the extreme distance limits of telephonic speech. This fusion of the Bell interests has grown to be one of the greatest " trusts " in the United States. Its total capitalisation is, I think, somewhere around 700 million dollars, and its president, Mr. Theodore Vail, is one of the financial powers in the land.

The number of " Independent " companies runs into hundreds. Some of them are large and comparable with the Bell companies, but for the most part they are quite small. The operations of the small companies are, in many cases, confined to a single town. They came into existence as the result of local enterprise, on the expiration of the Bell patents several years ago, with the idea of cheapening the service by competition. Taken altogether they now own about half the total of 8,000,000 telephones. The spirit of competition between the Bell companies and the independent companies is very keen. It has banded the independents into a fairly coherent group, which strives with might and main, and with a vast amount of sound and fury, to get the better of its formidable rival. Many of the advertisements and counter-advertisements are distinctly amusing, and the battle is followed with much relish and appreciation by the general public. The Bell group has the advantage in organisation, and in the possession of its fine system of intercommunicating long-distance lines; on the other hand, the balance of local sentiment and local capital investment is generally with the independent companies. There is, of course, no intercommunication between the rival systems — the Jews have no dealings with the Samaritans — and the quasi-competition plus intercommunication which the British Post Office has for some years been carrying on with the National Telephone Company is beyond their comprehension. Consequently many people have to rent telephones from both the companies in their district in order to keep in touch with their business associates, which is, of course, a very unsatisfactory state of matters. Generally speaking the tariffs of the independents are lower than those of the Bell companies in the same towns. Where the opposite is the case the Independents claim that the rates of their opponents have come down as a result of competition, and in most cases I daresay they are right.

The number of free services given by many American companies is rather noticeable; by this I mean little incidental services for which no charge is made. For example, it is quite an ordinary thing for a person to give the telephone exchange notice that they desire to be awakened at a particular hour next morning, or even to make an arrangement for every morning. And the telephone company does it! At Chicago we were told that no fewer than 80,000 subscribers in a day call up to inquire the correct time—and they get it. Election results and the results of baseball matches and other sporting events are also circulated freely to all who want them. In these matters there is no scruple about unfair competition with the regular news agencies, such as disturbs the gentle hearts of English telephone authorities.

I think the "limit" in this matter of special requests was reached by a certain lady we heard of at St. Louis, whose desire to visit one of her friends was in painful conflict with the necessity of watching her sleeping baby, until the bright idea of seeking the aid of the ever-useful telephone operator flashed across her mind. So she called up the exchange and explained: "My baby is asleep and I am just running over to see Mrs. Brown, her number is 5000 Main, I'll just take the receiver off and put the telephone down beside the cradle, you keep listening, and if you hear the baby cry ring me up at Mrs. Brown's." Whether or not the operator dropped all other business to give the necessary attention to this ingenuous request I don't know—and "I don't think."

I am afraid I must admit that the telephone service is distinctly smarter in the large towns of America than it is with us. We have plant and equipment practically identical with that of New York or Chicago, yet the result in speed of service does not seem to be as good. So far as I have had chances of observing in the States, all classes of workers—builders, porters, street excavators, meat packers in Chicago, iron and steel workers in Carnegie's Pittsburg mills, factory hands of all kinds, waiters, clerks, telegraphists, and, I fear

I must add, telephone operators—seemed to apply themselves to their business more diligently and whole-heartedly and with more effortless efficiency than we are accustomed to see on this side. Yet in America telephone operators are much more difficult to get than in this country, and might therefore be expected to adopt more easy-going and independent ways. They have to be attracted to the service by artfully contrived literature showing the supremely fortunate lot of the telephonist, the agreeable society she enjoys, the dining clubs, reading rooms, and rest rooms provided for her comfort and delight; all is attractively spread out to view, and only the trifling and apparently irrelevant fact that she is expected to do any work seems to be left unmentioned.

The long-distance service in America is often referred to as much more prompt than that given by the British Post Office, but the general statistics of the two services as a whole show that the average delay before a trunk connection can be obtained in England is not very much greater than it is in America. The superiority of the American service is principally in communication between large centres, and in this respect it is indisputable. The explanation is simply that trunk lines between the principal cities are provided in America on a much more lavish scale than has been done in this country. Consequently the American rates are high, as a matter of fact they are two or three times as high as the British Post Office charges for conversations covering the same mileage. This is a very important point which should not be lost sight of when comparing the two systems. The public pays with the usual American readiness, but nevertheless the statistics show that the trunk service is relatively much less used than it is in this country—another very important point in comparisons of public utility. The small man cannot afford the luxury of as much long-distance telephoning as he can here, and the richer users, who can afford it, get the benefit in promptitude of service. In this country, with its lower charges, the trunk lines carry far more traffic, and one has to wait longer for one's turn. It would be a hard matter to get the British public to stand the increase in the trunk charges necessary to pay for the building of the great numbers of additional lines which would be required to bring the service up to the American standard. Each line must bring in an adequate revenue to pay for working and maintaining it if the service is to be conducted on a business footing, and the problem the Post Office has to face in the speeding up of the trunk service is not at all an easy one. I may say that not only do our trunk lines show a much smaller proportion of idle time than those in America, but the proportion of waste time, that is, time occupied in passing calls and arranging for connections, is also much lower.

The less ample provision of lines in this country has forced the Post Office to study very keenly how to get the maximum amount of traffic over them in the busy hours of the day, and in this respect we have little to learn from America.

On the point of quality of speech transmission there is not much to choose between the two administrations; if anything, I think, the balance is in our favour. Our lines are, on the average, more carefully constructed. I had many long-distance conversations, and as a rule I found that communication above 400 or 500 miles was not at all easy. There are some specially good lines between important cities, and if one is lucky a very fair talk may be obtained between New York and Chicago—950 miles.

We were so fortunate as to be among the first to make trial conversations over a newly completed heavy line between New York and Denver, Colorado, a distance of more than 2000 miles. This line has been built with the greatest care, and on the most up-to-date methods. The result of our trial was poor, but the weather had been stormy, and we quite shared the hopes of the American officials that under better conditions the line would be quite good enough for commercial use. It has now been opened for actual traffic between New York and Denver.

The wonderful constitution of this "loaded phantom" circuit is described by Mr. Martin in another part of the present issue of the JOURNAL (at least I heard the Managing Editor make him promise to do so!). Its construction is the biggest thing yet done in long-distance telephony, and must excite the admiration of everyone who is in a position to appreciate the mathematical ability and electrical engineering skill that have contributed to so striking a result.

We are getting accustomed on this side to the use of the word "phantom." It is a characteristic example of the inventive locution of the Americans which hits off very aptly the characteristic of a superimposed circuit having no real physical existence. They have gone so far as to try superimposing a further circuit upon two phantom lines and describe this tertiary emanation as a "ghost" circuit. One can imagine the process carried a step further and the probable emergence of a "spectre," or, it may be, a "superastral" circuit, as the result.

All telephone engineers are at the present time keenly interested in the subject of automatic exchanges, and we did not fail while in America to see all that there was to be seen in that direction. The main idea of automatic working is to reduce the working costs of exchange services by enabling a subscriber to obtain the connection he requires by his own action and without the necessity for employing operators, but improvement in speed of service is also claimed. Each telephone instrument is provided with a mechanical calling device by means of which the person desiring to speak can, in a very simple manner, transmit the number of the party wanted.

In some systems this calling device includes a series of small levers, each of which is pulled forward to a position corresponding to one digit of the number to be signalled. In other systems it consists of a simple rotatable dial with ten numbers, 0 to 9, marked around its periphery, and a call for any number is sent in by turning the dial to zero from the position corresponding to each digit in the number successively. The signalling of each digit sends in a train of electrical impulses which actuate selecting and connecting mechanism at the exchange and so effect connection with the wanted line. The original conception of such a system is now over twenty years old and is generally ascribed to Mr. Strowger, whose name is still associated with the system now owned by the Automatic Electric Co. of Chicago, which has attained a much greater degree of practical development than any of its rivals. A very bold and striking conception it was, and, like many others of its kind, it was very coldly received in its early days. It looked too much to expect that mere machines could successfully pilot thousands of calls per day through the vast intricacies represented by the exchange systems of large cities. But the necessary faith and brains and money have been forthcoming, and the position to-day is that the majority of telephone engineers are very much disposed to believe that, in one form or another, these automatic machines are destined to play a great part in the telephony of the future. The idea was born in America and its most important developments have also been carried out there. During the past five or six years great strides have been made both in designing and perfecting automatic systems and in establishing working installations. At the present time there are not less than 250,000 telephones working through automatic exchanges in the United States. More than 95 per cent. of these are on the Strowger system as developed by the Automatic Electric Co., and the remainder are the product of other companies whose engineers have devised systems both notable and effective.

Semi-automatic systems are also pushing themselves to the front. For semi-automatic working a subscriber only requires an ordinary common battery telephone. The attention of an exchange operator is gained in the usual way by lifting the receiver, and the automatic mechanism is set in motion by the operator. She receives the required number verbally from the calling subscriber and taps it out on sets of numbered plungers; the machines do the rest. The speed at which the operator can handle calls in this way is far greater than is possible on an ordinary manual switchboard, where she has to connect the calls through by means of plugs and cords, and to test and ring on the wanted line.

The actual selecting mechanism for semi-automatic exchanges is practically identical with that used on full automatic systems. The principle of both systems is simple and can be readily grasped by the general reader. Suppose a subscriber on a full automatic system wants to obtain connection with number 4683. He will first send in the figure 4 from his calling device, which will transmit four electrical impulses over his line. These impulses act upon a piece of switching mechanism known as a first selector and step its contact brushes or wipers forward into connection with a junction line leading to the fourth thousand group. The other end of this junction line is permanently connected to a second selector, which has access to the lines of all subscribers whose numbers lie between 4000 and 4999. The second figure, 6, will then be sent in, and will step up the wipers of the second selector into contact with a junction to a third selector, or "connector," on the sixth hundred group. To this connector all the lines between 4600 and 4699 are permanently joined. The transmission of the third calling figure, 8, will step up the wipers to the "80" group, and the final figure, 3, will carry them three steps forward into contact with the required line 4683. These are the essential operations, but in the actual arrangement of an exchange a great number of subsidiary details must be carefully provided for. There are automatic selecting switches which come into operation immediately the receiver has been lifted, and which pick out an idle first selector and place it in connection with the calling subscriber's line, in readiness to receive the first figure of his call. The various selectors at each stage have not merely to find the group required, in response to the calling impulses, but they have also to hunt for and locate an idle junction circuit to a selector in the next order of numerals. The junction circuits to the group required are tested rapidly one after another, and as soon as an idle circuit is reached it is grabbed by the mechanism, and the connection of the calling-line is made to it, after which this particular junction circuit will test as "busy" on all the other switches to which it is joined.

The final connector also has to be provided with means for testing the line wanted and for sending a "busy" signal back to the originating subscriber if his desired correspondent should be engaged with another conversation. Further, if the subscriber required has several lines it must locate and connect an idle one, and then proceed to ring his bell at short intervals. If he should be a "party" line subscriber, sharing a line with others, it must arrange the connections and bring into use the proper kind of ringing current to call him without disturbing the other parties on the line. After the connection has been made, and the party rung has replied, the mechanism must register the call on a meter, if the service is given at measured rates.

It must also hold the busy test on all junction lines and switches in use, in order that all intruders, mechanical or otherwise, may be warned off while the conversation is in progress. Finally, when the conversation is over and the subscribers have hung up their receivers, all the switching parts must be restored to normal, the busy tests removed, and the whole made once more available to handle a fresh call.

As a rule automatic exchanges include also a system of warning signals to attract the attention of the attendants to any failure of the apparatus to perform its functions properly, and means have also to be provided for obtaining connection to trunk circuits and other exchanges, manual or automatic, in the same area. Indeed, there are a good many simpler things to be found on this planet than an automatic telephone exchange.

Up to the present the great Bell companies in America—the companies whose engineers have, as I remarked above, shown the way to the world in the construction of manual exchange switchboards—have refused to touch automatics, and have consistently maintained a keenly critical attitude with regard to them. All the development of automatic working which has taken place has been in the systems of independent companies. At the present moment the independent telephone company in the highly progressive city of Chicago—the Illinois Tunnel Company—is installing an automatic system for 80,000 subscribers in eight exchanges of 10,000 lines each. All these exchanges will be inter-connected and work together as a single unit. The apparatus equipment is planned on a basis which will permit of the ultimate extension of the system to practically one million lines. The exchanges were being constructed when we were there in January last. Already there are over 20,000 lines working, and I am told that exchange agreements have already been obtained from more than 40,000 subscribers, whose equipment is being pushed on as rapidly as possible. When one considers that Chicago, with a population of about three millions, had more than 250,000 telephones already working on the Bell Company's system before the new competitive system was started, the pluck and assurance of the independent company in launching out on the new scheme is quite striking. We happened to be in the company's head office one evening when the canvassers—"solicitors" they call them in the States—were returning to report their day's progress. They thronged the staircase like a crowd going into a theatre, each man carrying under his arm his sample automatic telephone, the transcendent merits of which had, no doubt, been depicted in glowing terms to as many go-ahead Chicagoans as he could persuade to listen. It made one wonder how many telephones there would have been in England to-day if the business had been pushed here with the same determination.

As already mentioned, the Bell companies are not yet converted to the automatic system, nor do they admit that the public can be expected to handle the automatic telephone successfully. But they have apparently now reached the stage of admitting that the exchange portions of the apparatus, at any rate, promise to work satisfactorily, for they have commissioned the Western Electric Co. to work out for them a semi-automatic system. This system is now working in New York in an experimental form. The installation only includes 500 lines, but it is designed on a plan that will provide for ultimate extension to serve nearly two millions of intercommunicating subscribers, whose lines may terminate in, say, 100 exchanges of 20,000 lines each. So the needs of the largest cities for many years to come are being fully kept in mind. There is no reason in the nature of things why another numerical digit should not be added to bring the system up to 20,000,000, although the complexity of such an installation staggers the imagination, and the operation of calling would be rather a long one. It would be necessary for a subscriber to operate his calling device to send eight figures to reach a correspondent whose number was a high one on the list. As a matter of fact, however, the capacity of any properly designed automatic system is, *in theory*, without limit.

The semi-automatic system which the Western Electric Co. has designed is on an entirely original and novel plan and is a miracle of ingenuity. It can readily be adapted to the requirements of full automatic working, and the company's engineers have, in fact, a scheme fully matured for this purpose. Their system, in either of its forms, is bound to be a formidable competitor with other systems in the struggle which may ultimately be expected to result in the survival of the fittest.

The Post Office has now determined to make a trial of automatic exchanges in this country. The first move will be to "try it on the dog," by having an installation to serve as the official switch system at the G.P.O., and it will not be long before two or more systems are working in public exchanges also. It is only in this way that it can be ascertained whether the British public will take kindly to such devices. So far as America is concerned, we took every available opportunity of getting at the attitude of the public. We visited many subscribers who are connected both to the automatic system and to the competing manual system of the Bell companies, and I am bound to say that in the great majority of cases we have found a decided preference for the automatic. There are several reasons why one should accept such a result with caution and not build too much upon it, but it certainly seems to be the case that the average man likes to get through by his own effort, without waiting for the attention of an operator. As a rule, in eight or ten seconds he will either have got through to the number he wants or will have received a "busy" signal. Another point which most subscribers appreciate is that the replacement of the receiver on completion of a conversation clears the line instantly, and a fresh call can be made at once. Of course the crux of the question is—Will the automatic be cheaper to instal and work than the manual system? Will it enable rates to be reduced to the public? If so, its success is assured. There is naturally a big saving in the elimination of operators, but against that has to be set increased cost for skilled mechanics for maintenance, and probably more rapid deterioration of the apparatus. If it should prove that there is no appreciable difference in cost, I for one should prefer to keep on with the manual system. I think it is much better as a general social proposition to pay operators for doing positive useful work than to spend the same amount in paying men to hunt for faults in complicated mechanism, and to cure trouble after it has arisen. All the same, I believe that in one form or another automatics have come to stay.

Perhaps I might now go right to the other end of the telephone field—to the simplest end so far as apparatus is concerned—and mention the rural services of America. The development of "farmers' lines" is a distinctively American product, and is largely due to the initiative of the people themselves, who had constructed a great many lines in far out-lying country districts before the telephone companies had made the discovery that there was a big revenue to be derived from the cultivation of such rural services. Some very weird productions were to be found among the lines built by the farmers in the earlier days. An extra long post in the snake-fences here and there, with a bit of fencing wire strung along on broken bottle necks spiked to the top of them, to serve as insulators, was all that was wanted to put ten or a dozen farmers into useful communication with one another. Now the lines are a little better constructed, but to a great extent the farmers still build them for themselves. Many firms of telephone suppliers all over the country cater for their wants. A line may wander around to as many as twenty residences and look in casually at an exchange, or sometimes two exchanges, through which communication with the outer world, or, at least, with the nearest market town, can be obtained. Long-distance talks are outside the limits of possibility; the lines are hardly of the class required for achievements of the New York-Denver grade. Each telephone has a powerful hand generator, and the calls reach all the parties on the line. A code of signalling has therefore to be arranged, so that each may know when he is wanted, and when the number of parties on a line is more than six a system of combinations of long and short rings is used. Of course, everyone can overhear his neighbour's business if he wants to; it has even been said that this is one of the main reasons for the popularity of the system! I had an opportunity of spending a Sunday with some relatives, pretty far out in Missouri, who had the farmers' service, and I was told that when a call was sent or received it was necessary to get the essentials of the conversation over as quickly as possible, for the speech gradually got more and more feeble as one after another of the parties who had *not* been called came into circuit to hear what it was all about. I did hear, too, of an old lady, who, after visiting an exchange and seeing the head-gear receiver which the operator wore, promptly applied for a similar one for her telephone. She said it made her so tired holding the ordinary receiver to her ear all the afternoon when she had nothing else to do! And of yet another case where the ringing regularly failed on a certain line for the same two hours every evening. After the "trouble hunters" had exhausted their ingenuity in unsuccessful attempts to trace the fault, they discovered accidentally that a certain good lady who had a telephone on the line used to darn the family stockings at that time every day. She had discovered that the smooth body of the receiver came in very handily for that operation. I am afraid that to give this last story a fair amount of verisimilitude it is necessary to postulate rather a high degree of wear and tear in the household stockings!

With all its quaint associations the farmers' line is still a splendid thing for rural America. It has wonderfully mitigated the loneliness of life in the small farms that are dotted about over so many thousands of square miles, and in every way it has brought great business benefits to the farmers as well.

Another point that might be mentioned is the comparative ease with which the telephone companies in the States are able to keep their lines clear of trees. Not only does the dry climate greatly assist them in maintaining good insulation, but landowners adopt a far more reasonable and public-spirited attitude in the matter of permitting tree-cutting than we are accustomed to on this side.

I seemed to have found an exception to this in the experience of one American official who rather surprised me by referring to the "unreasonable" trouble he experienced in getting tree-cutting permits, until I realised that the permission he expected was to cut the trees *down*—to clear them out of the way once and for all.

Of the many things we saw and admired in the telephone world of America, there is none that impressed me more than the quality of their organisation, the statesmanlike ideas which underlie it, and the hearty way in which all appear to believe in it and to support it. This organisation is typical of general American methods, and to it much of the national success is due. Its three fundamental ideas are reasonable specialisation, devolution of responsibilities, and direct co-operation between officers whose work is associated.

The Post Office appears to be moving in the same direction. Specialisation it has already got to a great extent. Devolution of powers from the headquarter authority is going on, and may be expected to go much further. In this respect it can never go as far as the American telephone companies, where the chief operator at an exchange is generally vested with the duty of engaging her own operating staff, and of discharging inefficients and undesirables—vividly described as the power of "hire and fire." Nor is it at all desirable that it should.

The substitution of direct discussion and co-operation between associated branches for the present system of co-ordinating and governing them separately, by means of a general headquarter staff, which forms the recognised channel of communication between them, is, however, a matter well worthy of attention by the Post Office.

One of the most salient points of the American organisation to an engineering man is the broad-minded definition given to the word "engineering." The Chief Engineer of the American Telephone and Telegraph Company has under him "traffic" engineers as well as "plant" engineers, and is thus able to deal effectively with the development and requirements of the services as a whole, and to formulate standards of construction and of operating practice in proper relationship with each other, for the instruction and guidance of all the associated Bell companies, and of the wide telegraph interests which are also under his control. These telegraph interests were formerly restricted to the leasing of "private wire" circuits superimposed on the long-distance telephone lines, but they have recently been greatly extended by the practical acquisition by the American Telephone and Telegraph Co., of the Western Union Co., with its cable system and extensive inland telegraph business. The amalgamation was, I believe, largely due to recognition of the benefits which would result from the co-ordination of the two services, and the best methods of doing so are now being actively studied. A leading official of the American Telephone and Telegraph Co. is at present in England with that specific object, and I was pleased to hear from him that he had derived much assistance from his investigation of the methods already adopted by the Post Office for rendering the telegraph and telephone systems complementary one to the other. I have little doubt that we shall soon see noteworthy developments in the same direction in the United States, with conspicuous benefit to both the sister services. The matter is especially interesting at the present moment when one hears rumours that the Post Office is flirting with the retrograde idea of dissociating the two services and conducting them independently.

The value of regular statistics is much appreciated in America as a means of supervising the working of large commercial organisations of all kinds, and the greatest attention is paid to framing them systematically on lines which will yield the essential information required by controlling officers. The telephone companies are no exception in this respect. We were informed that the leading ideas in organising statistical methods are, first, that no man shall be asked to furnish statistics which are not of practical use to himself in gauging the success of the work for which he is responsible, and second, that the system of standard records shall be so complete as to avoid, to the utmost possible extent, any necessity for calling upon the staff to interrupt their normal duties for the compilation of special returns. The records pass through many hands and many processes of refinement, useful at each stage, before they ultimately reach the heads of the company in a shape which enables the working of every important branch of the business to be reviewed in terms of the all important criterion—dollars and cents.

The apparent harmony with which all classes work together in the American services is striking. Two or three times I commented on this, and the reply in each case was to the same effect—" Employ high-grade men and there will be no friction "—with which excellent sentiment I will wind up.

THE Board of Editors have pleasure in stating that Messrs. Martin and Jones will contribute articles to the next issue of the JOURNAL dealing with their American visit.

ADVERTISING THE TELEPHONE.

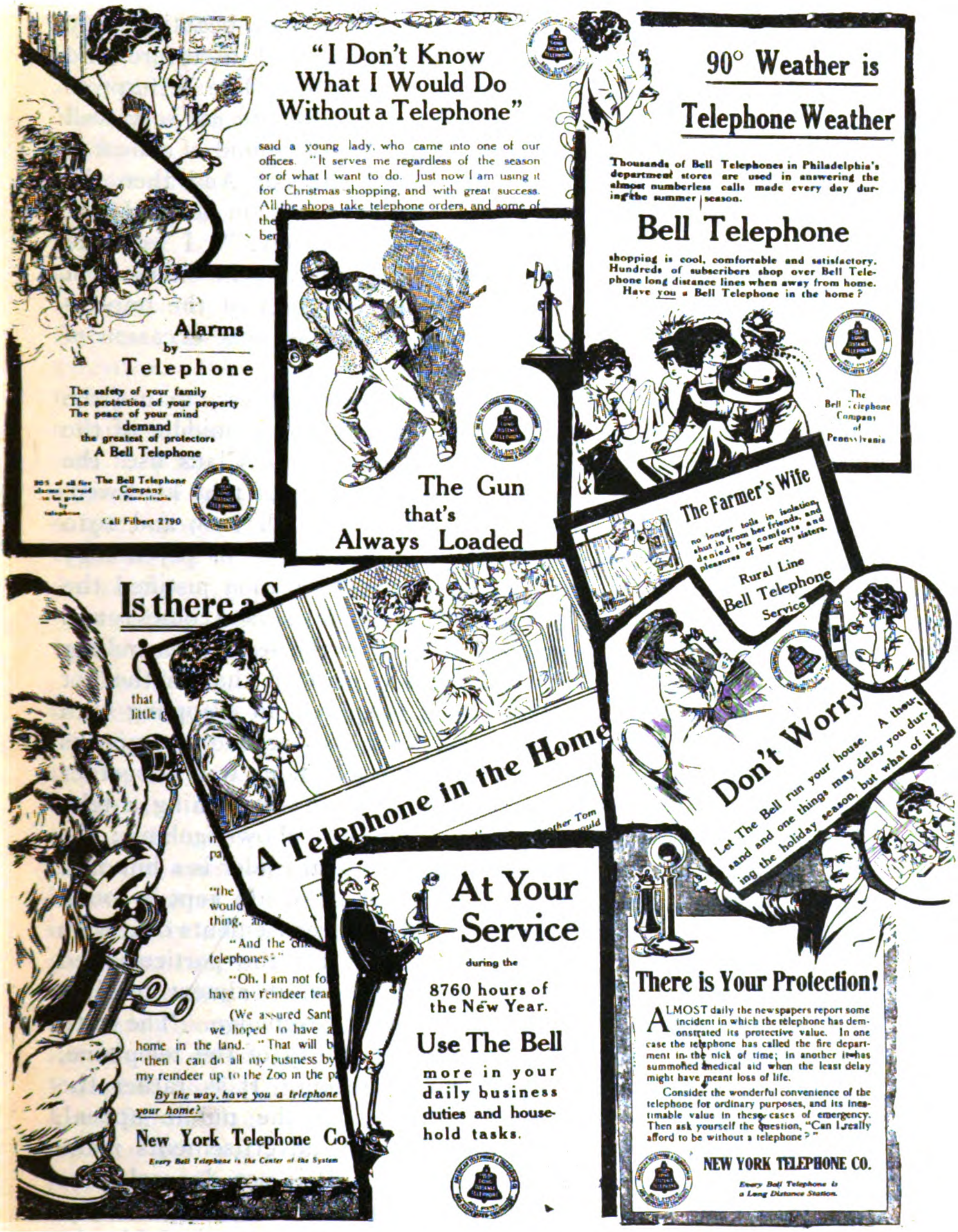
By JOHN LEE,
Traffic Manager.

THE most impressive sight we saw in America was a meeting of the New York Telephone Society. In a large theatre of the Engineers' Club—a beautiful building given by Mr. Andrew Carnegie at a cost of "a million and a half or so"—something like 1500 men, mostly young, were assembled. An admirable paper on the commercial work of the telephone company was given by one of the commercial managers. It outlined the methods employed in canvassing and advertising. It revealed the intimate psychology of the process. It showed how the weaknesses of our common human nature were taken into consideration, how the world was convinced of the absolute necessity of a telephone in business enterprise and in domestic relationships. Not all of that fine audience were on the commercial side of the tripartite functions. Some were plant engineers, some were traffic engineers, some were local managers and agents. But the very excellent Society sets out to give each member an insight into the work and ways of branches with which he is not directly concerned. It is a worthy ideal. It broadens the vision and enlarges the interest. Yet it does not connote for a moment that there is any misapprehension as to responsibility. The reader of the paper had no anxiety lest anyone should argue that the work which he described should be attached to another branch.

It is necessary to say this at the outset, for in England we are certainly exposed to such a danger. In the last issue of this JOURNAL an article was copied from the 'Times' in which an attack was made on the present method of controlling the Post Office telephones. I can speak of this article with appropriate geniality, I hope, even if I belong to the section which was bluntly described as inefficient and untrained. But if I attempt to describe in these pages the outline of American methods of advertising, I must not be understood as claiming that this work comes within the scope of "engineering" as we use the word in England. I would urge merely that it is of interest to each of us, whatever our capacity or function may be. We can surely meet on a common ground, recognising each other's work, and recognising work which may properly belong to neither of us, without the suspicion that we are engaged in a particular propaganda, and a propaganda which has elements of disloyalty both to the arrangements as they stand and to the spirit of fraternity which ought to be characteristic of telephone enterprises as a whole.

The psychology of advertising has received much attention in America. Lectures are given in at least one of the universities on the underlying philosophy of the advertising art. The idea is that the subconscious mind is what Locke said of the mind as a whole, —a *tabula rasa*. On this virgin wax many impressions are received and we know nothing of them. We are storing up in our mental furniture a host of ideas. They concern pills, shirts, boots, literature, watches, motor-cars, and type-writers. Day by day the advertiser strengthens the impression; he "rubs it in." The patient subconscious mind accepts it all, and when the moment comes for revelation, the impression springs, a vivid reality, into open consciousness. We have a pain—we think of certain pills at once. We have an uncomfortable shirt—the subconscious mind whispers to us of so-and-so's ever-comfortable shirts. We are athirst for information—the intolerability of life without the 'Encyclopædia Britannica' is at once evident. Here, therefore, we find the first canon of advertising. It must hammer home one central idea on the subconscious mind. It must not look anxiously for direct results. It will get the results in due course, but that is a second process, and belongs to what the philosophers call the "collecting" period, a word which has philosophic kinship with our word "re-collecting." Its primary idea is to gather up in the stores department of the human mind certain information which will be available at the moment of need.

So the advertising of the telephone is divided into two distinct propaganda. There is the general propaganda: the telephone is useful to everyone. It saves time and money, temper and trouble. It is an ever-ready servant. It is quicker than the post and more trustworthy than a messenger. It is preciously intimate, the binder of broken friendships and the solvent of civilised isolations. Day by day such asseverations are made. Their truth is unimpeachable. But bald general statements do not "drive home." They need to be focussed into something of direct interest, and the prevailing sentiment of the hour is used to catch the public eye. One of the best of these efforts was at the time of the recent explosion in New Jersey. The buildings in New York had been shaken to their foundations. There had been grave public anxiety; so the Telephone Company came out with an excellent advertisement in the newspaper: "Thousands rushed to the telephone. Husbands were anxious about their wives. Wives were anxious about their husbands. In a few moments the business of New York went on as before, for the anxiety was allayed. Have *you* a telephone in your home?" It was part of the general propaganda, but it had special point by reason of the fact that it chose as a peg the topic which was in everyone's mind. That is the sound philosophy of advertising.



"I Don't Know What I Would Do Without a Telephone"

said a young lady, who came into one of our offices. "It serves me regardless of the season or of what I want to do. Just now I am using it for Christmas shopping, and with great success. All the shops take telephone orders, and some of the

ber

90° Weather is Telephone Weather

Thousands of Bell Telephones in Philadelphia's department stores are used in answering the almost numberless calls made every day during the summer season.

Bell Telephone

shopping is cool, comfortable and satisfactory. Hundreds of subscribers shop over Bell Telephone long distance lines when away from home. Have you a Bell Telephone in the home?

The Bell Telephone Company of Pennsylvania

Alarms by Telephone

The safety of your family
The protection of your property
The peace of your mind
demand
the greatest of protectors
A Bell Telephone

90% of all fire alarms are said to be given by telephone

The Bell Telephone Company of Pennsylvania

Call Filbert 2790

The Gun that's Always Loaded

The Farmer's Wife

no longer toils in isolation, shut in from her friends, and denied the comforts and pleasures of her city sisters.

Rural Line Bell Telephone Service

Is there a S

that

little g

pa

"the

would

thing," an

"And the

telephones?"

"Oh, I am not fo

have my reindeer tea

(We assured Sant

we hoped to have a

home in the land. "That will b

"then I can do all my business by

my reindeer up to the Zoo in the pa

By the way, have you a telephone

your home?

New York Telephone Co.

Every Bell Telephone is the Center of the System

A Telephone in the Home

Don't Worry

Let The Bell run your house. A thousand and one things may delay you during the holiday season, but what of it?

At Your Service

during the

8760 hours of the New Year.

Use The Bell

more in your daily business duties and household tasks.

There is Your Protection!

ALMOST daily the newspapers report some incident in which the telephone has demonstrated its protective value. In one case the telephone has called the fire department in the nick of time; in another it has summoned medical aid when the least delay might have meant loss of life.

Consider the wonderful convenience of the telephone for ordinary purposes, and its inestimable value in these cases of emergency. Then ask yourself the question, "Can I really afford to be without a telephone?"

NEW YORK TELEPHONE CO.

Every Bell Telephone is a Long Distance Station.

Some American Telephone Advertisements collected by Mr. John Lee during his Recent Visit.

But a calamity is not always at hand, so a calamity is not always necessary to the general propaganda. In the middle of last winter one of the companies issued a very pretty and effective newspaper advertisement. The picture showed a very beautiful lady sitting in a dainty boudoir, with pianoforte and literature and needlework—and yet she was obviously lonely. The letterpress explained it. "Books, needlework, music—these are all very well to alleviate loneliness, but a woman longs for the sound of a human voice. She longs to speak of the intimate things. And then the telephone bell rings—'Oh, Edith,' she says, 'I am so glad you rang me up, for George is away, and I was so lonely.'" I feel sure that such an advertisement awakened a responsive echo in many a gentle heart in Morningside and Montclare. At least the impression would arise in the conscious mind on the next occasion of loneliness, and that, of course, is the real aim.

Efforts are made, with very considerable success, to use the seasons of the year as a basis. For example, in the middle of the Christmas shopping season we are told that Santa Claus uses the telephone to very good purpose. Advertisements of that kind were used by the New York Telephone Company in both 1909 and 1910 respectively. If one may judge of the hidden secrets of psychology which govern these things, the advertisement in 1909 justified the repetition of the same idea in 1910. When holiday season comes round a picture is given of the business man away at the seaside controlling his affairs in New York. Similarly, it is claimed that in the hot weather nothing is so successful as a telephone in grappling with the inconveniences of the heat, just as it was argued six months before that in cold and frost and snow the telephone was altogether indispensable. The small boy on July 4th is shown twining a telephone wire amid his fireworks. The lawyer is shown golfing; the physician is motoring for pleasure; the political leader is a hundred miles from home, or a thousand, and all of them are kept in touch by the telephone. Singularly few of these advertisements deal with business proper in any form. This is left for the particularised method of circulars and personal canvass, and it almost resolves itself into a propaganda for the private branch exchange. The truth is that the day has long gone by when the utility of the telephone, in respect of business, needs any demonstration. It is rather the social side of life nowadays which calls for the public appeal. Hence it may be said that more than half the advertisements make their appeal to women rather than to men. It is not due solely to the fact that the United States is pre-eminently a woman's country, though this is beyond dispute. Rather it is that the next field to be conquered is that in which woman is specially triumphant.

Apart from general calamities there are particular emergencies in which the telephone is especially useful. With cunning art these are made the basis of alluring advertisements. One of them represents a business man who is invalided, conducting his business by telephone as he lies abed. To most of us this might be a positively repelling appeal, but the fact is that it is a particular utility which is highly esteemed by our cousins. The great railway king, Harriman, may almost be said to have died with the telephone in his hand. Another series of pictures deal with illness in the home. We see the boy, ill of scarlet fever, lying on his bed, with his mother in attendance. She is a prisoner, of course, but by her side is a telephone, and her smiling face as she uses it shows that it has had some influence in relieving *tedium vitæ*. Other pictures of invalids show us the victims with wearied faces and usually dressed in elaborate dressing-gowns, but in all cases the telephone is their salvation. Burglaries form topics of a lurid type. The Philadelphia Company issued one particularly thrilling picture. It represented a burglar, pistol in hand, mask on countenance, dark lantern by his side. With indignant scorn he is regarding a telephone. "It ruined my business," he is saying. Another picture on the same subject shows us the policeman arriving in the nick of time, while a third shows us comprehensively how every wild alarm meets its destruction in the telephone. Fire-engines are shown tearing along the roadway as a result of a telephone call, and houses, barns, and warehouses on fire form the frequent subject of illustration.

The theories of psychology are carefully carried out by the use of antithesis. Not only are we given a picture of the pretty young lady who does her shopping by telephone with the temperature at 90° F., but we are shown a group of less wise ladies struggling at a counter, heated and distressed. The golfer who has a telephone handy is manifestly a better player (judging by his handling of the "driver") than the man who is a member of a club slightly less generous in the matter of telephones. The business man at the sea-side is sprightly and summer-like, and he seems to have dressed with particular care in order to use the telephone. The lady who faces spring cleaning without a telephone wears both a worried look and a worried blouse; the telephonic spring cleaning permits the rival lady to be dressed (apparently throughout the day) in the latest Paris hat, so that she looks as if she were going to a garden party. Even Santa Claus is improved in appearance by the use of a telephone: his beard is less uncouth and his face has a touch of juvenility. It is all sound psychology and sound economics. Each of these subtle points reaches the subconscious mind of the reader, and has its influence in making a generic impression that every good thing is procured by the use of the telephone.

Even in advertising farmers' lines the same subtlety is observed.

The farmer who uses the telephone is a sprightly young man, wearing the latest collar, and with trousers which show the marks of the press. The farmer who has no telephone seems to have a crop of troubles, whatever other crop he may get. His personal appearance is unkempt; his trousers, like Crusoe's, are shocking; his painfully vulgar braces are evident, and such of his shirt as they do not cover is not very creditable to his worried wife. In one picture he has a horse dead in a field. In another two barns are on fire. In a third a prairie fire shows signs of rapidly burning him out of house and home. I think that in such a case, unless the farmer wishes to see the end of all things, he had better have his telephone installed forthwith. Certainly it will improve him in every way; it will even add strength and firmness to his chin, brightness to his eye, and give him a wife of whose virtues perennial youth is not the least to be esteemed.

There is sound reason behind this clever advertising propaganda. To begin with, the telephone is the only article of commerce which is qualitatively of more value with the quantitative extension of its use. It is not of much value to me that 29,611 other people should get an 'Encyclopædia Britannica,' beyond the bare material fact that it enables me to get one cheaper. Nor do I care a straw whether the people in my suburb do or do not have the electric light, save that by an extension of users the price may be reduced. Nor am I anxious that the world should use the back-ache pills which give me such wonderful relief, or the bread-nuts or the cocoa which in time will build my muscle to the pitch of Hercules and my brain to the pitch of de Morgan. Hence (having myself succumbed), the advertisements for the 'Britannica,' or the back-ache pills, or the bread-nuts or the cocoa excite in me no feelings whatever. But I do want everyone else to have a telephone, since my own use is qualitatively more valuable with every new subscriber. Hence the advertisements lead me to the reflection that they are in my own interest. The more alluring they are the better the telephone subscriber likes them, and the more likely the non-subscriber is apt to like them. Moreover, it is possibly quite true that the alert mind which has led a man to be a telephone subscriber somewhat in advance of his fellows is evidenced also by his superiority in appearance. I do not think, therefore, that the American companies are exaggerating when they show that the telephone farmer is in advance of his non-telephone rival both in respect to the modernity of his braces and the comeliness of his wife. He is manifestly a thoughtful and enterprising man, and he has a wife (and braces) suited to his condition.

Should we advertise in England? In my opinion the answer is, Yes. I doubt if Englishmen want the death-bed telephone or the scarlet fever brand. At any rate I should not recommend advertising in that way. But I am sure that the psychology of advertising deserves careful study from the telephone point of view in order that it may be applied with due regard to English characteristics. The Americans have made a wonderful science of advertising: what seems to us to be exaggeration is generally the inner perception of fundamental subtleties, to which we ourselves have been blind. We owe a duty to the telephone subscriber to extend the range of his intimate relationship so far as we can. It is not merely that we are striving to add to the number of subscribers. Rather it is that we are accepting the responsibility, from the moment that we have attracted one subscriber, of proceeding without rest or restraint until there is no one in the country from whom that subscriber is severed. We have the influence of all our subscribers behind us in any such advertising propaganda, and there is no better way of showing the world that we mean business. Only it is no use advertising unless prompt connections can be given on the application of the public. Here I impinge upon engineering matters, and with courteous abruptness I must stop.

THE TELEPHONE IN BRITISH EAST AFRICA.

The following photographs and notes have been sent from Nairobi, British East Africa, by Mr. Lionel E. Caine, who says in his letter:

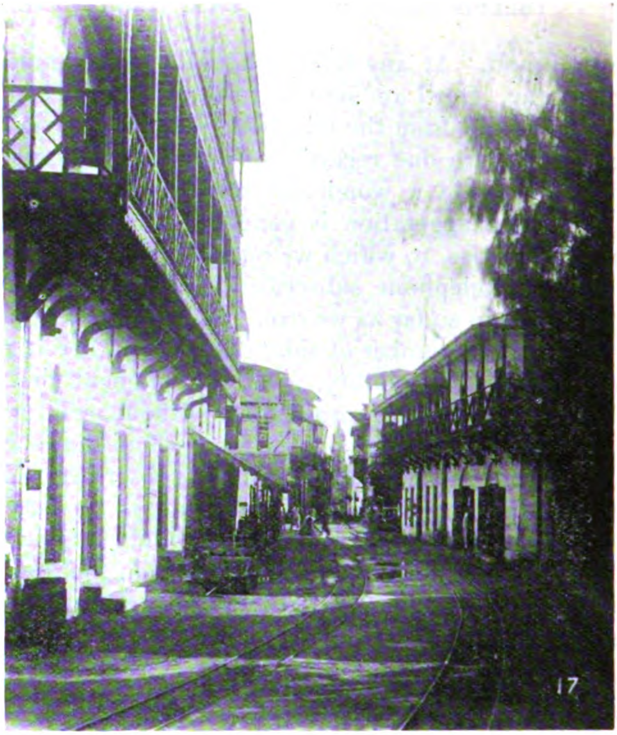
"Corresponding members exiled away in new countries are not likely to be in a position to teach much to members living in the metropolis of the Empire.

"Contributions from the Colonies may, however, possess a certain amount of interest to the stay-at-home members, or to other Colonial members, or to those younger members who may be contemplating transferring their energies to more roomy countries."

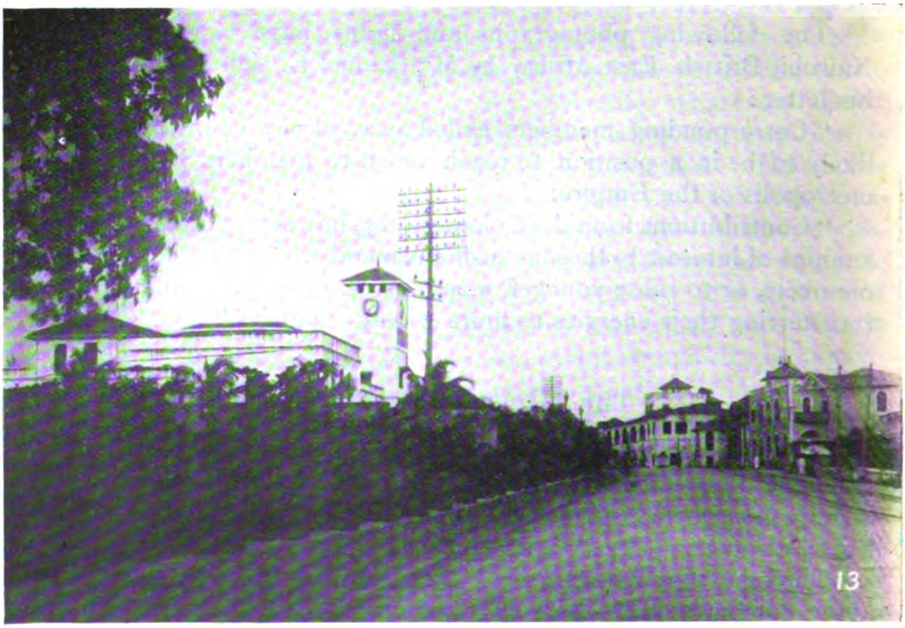
THE NAIROBI POST OFFICE.

The new Nairobi Post and Telegraph Office was opened in October, 1909. It looks isolated at present, but buildings are being rapidly constructed in the vicinity. The Treasury buildings appear in the distance. (See Frontispiece.)

The telephone wires run into the square tower, which can take in about 800 wires on the bare-wire system. We shall probably resort to cable long before that number is reached. From the top of the



1.—STREET IN MOMBASA OLD TOWN. *(Photo by L. E. Caine.)*



2.—TELEPHONE LINES IN A MODERN STREET IN MOMBASA. *(Photo by L. E. Caine.)*

tower the wires are led down to the multiple switchboard, which is on the first floor. We have at present only 100 connections. The system is magneto-metallic circuit. The magneto on the switchboard is worked by a motor.

The telephone poles are of local juniper (cedar).

The twist system of wiring is adopted.

3.—Mast, 170 feet high, on South Bank of River Tana, British East Africa.

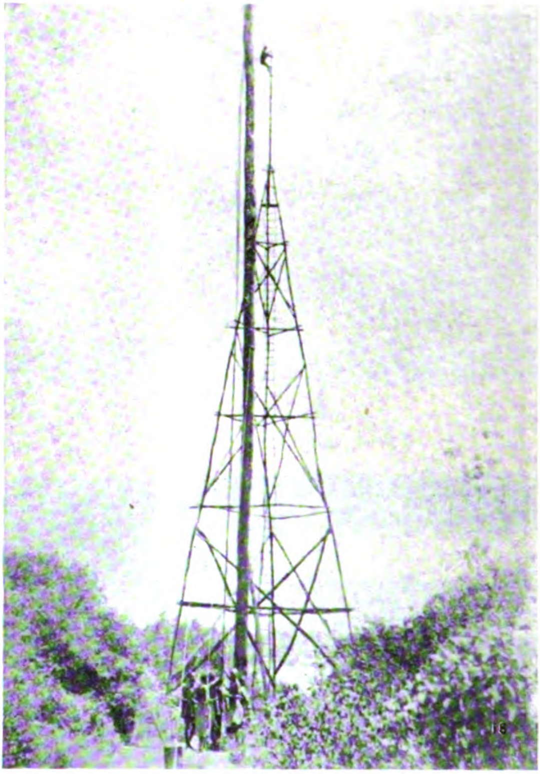
Mombasa Telephone Lines.

Of the two photographs, 1 shows the tortuous nature of the streets of the older part of the town, and 2 a broad street in the modern part.

The old Arab houses, being often built of rubble and mortar, make it difficult and dangerous to attach brackets to the walls for over-house wiring.

Iron tubular poles (galvanised) of the Hamilton pattern, with wooden arms, are the chief type of pole adopted in Mombasa.

We have not yet reached fifty subscribers, though practically all Government offices and the principal merchants' offices are connected.

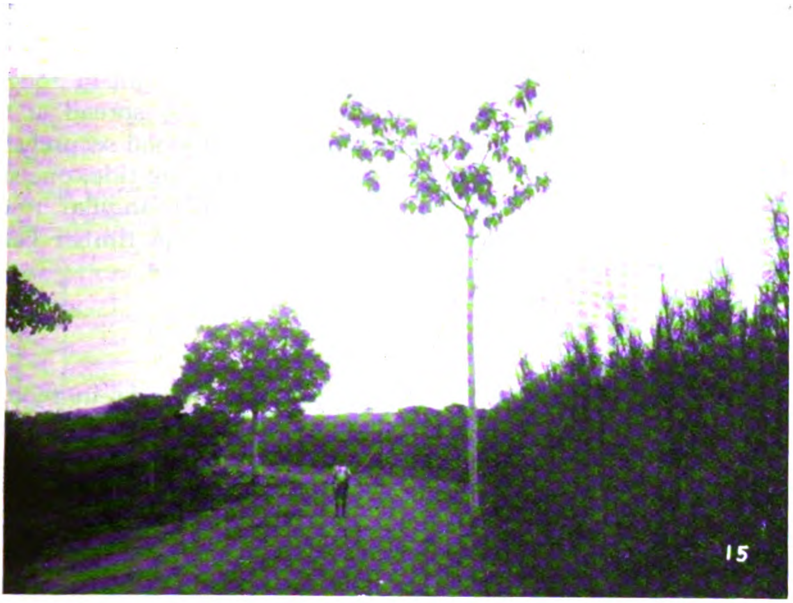


4—MAST, 150 FEET HIGH, ON NORTH BANK OF RIVER TANA, BRITISH EAST AFRICA.

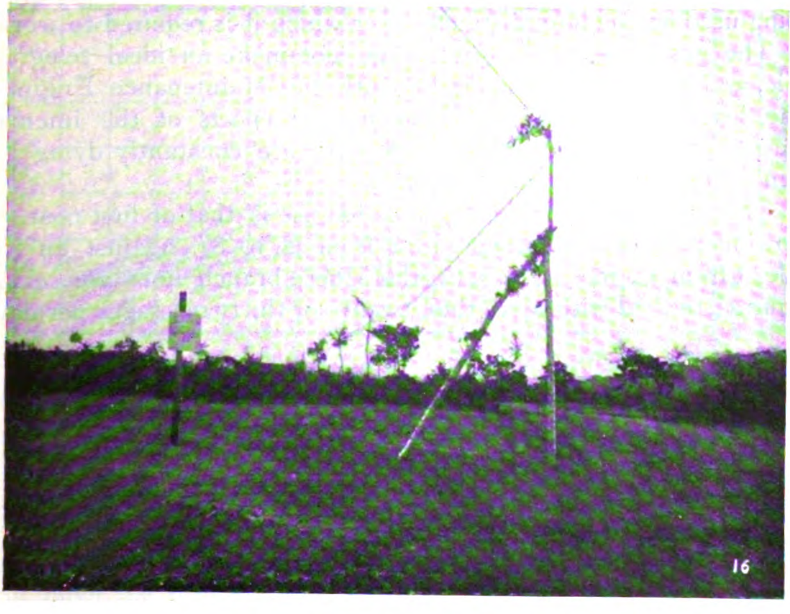
THE TANA RIVER MASTS.

The Tana River masts represent a very creditable piece of work by Telegraph foreman Mr. M. A. Black, who cut the wood out of mangrove swamps, and erected the masts without any real skilled labour. Native linemen were his only assistants.

The masts are in nine sections of from 22 to 16 ft. long, that on the South bank (see **3**) being 170 ft. high, and that on the North (see **4**) or left bank 150 ft.; the latter stands on a 30-ft. bank, while the



5.—Growing Telegraph Poles in Uganda. *(Photo by L. E. Caine.)*



6.—Growing Telegraph Poles in Uganda. *(Photo by L. E. Caine.)*

former stands just above water level. The masts are set in concrete. The span is above 400 yds., and the headway 100 ft., with a sag of 70 ft. Silicium bronze wire, 100 lbs. per mile, is used for the crossing.

.The triangular structure beyond the mast was built in 1907 to carry the crossing wire. It was hoped that the big spread at the base would guard against sinking in the sand. It stood securely for three years, and then after an exceptional high spring tide, one side began to sink, necessitating the new mast. The triangular tower was also erected by Mr. Black from my design, the timber being procured from the surrounding swamps.

GROWING POLES IN UGANDA.

While erecting a temporary telegraph line in Uganda in 1900, it was found that the poles cut for the line took root and burst into leaf soon after they were planted.

Since then the use of growing poles has been greatly extended, outlying districts being connected up by their means, so that at the present time we have over 500 miles of growing poles. The tree used is a species of wild fig, locally known as the bark-cloth tree, from the fact that natives use the bark for making a rough cloth which forms the sole clothing material for the majority of the inhabitants. Vibrating sounders are used on these growing pole lines, as the low insulation does not allow of the morse sounders being used on the long distances over which it is required to work.

The growing pole, however, does not make an ideal telegraph pole, and is far from a favourite with the Maintenance Engineer. The leaves occasionally get beyond the efforts of the lineman, causing leakage by contacts, and poles are constantly dying and being eaten by white ants (termites).

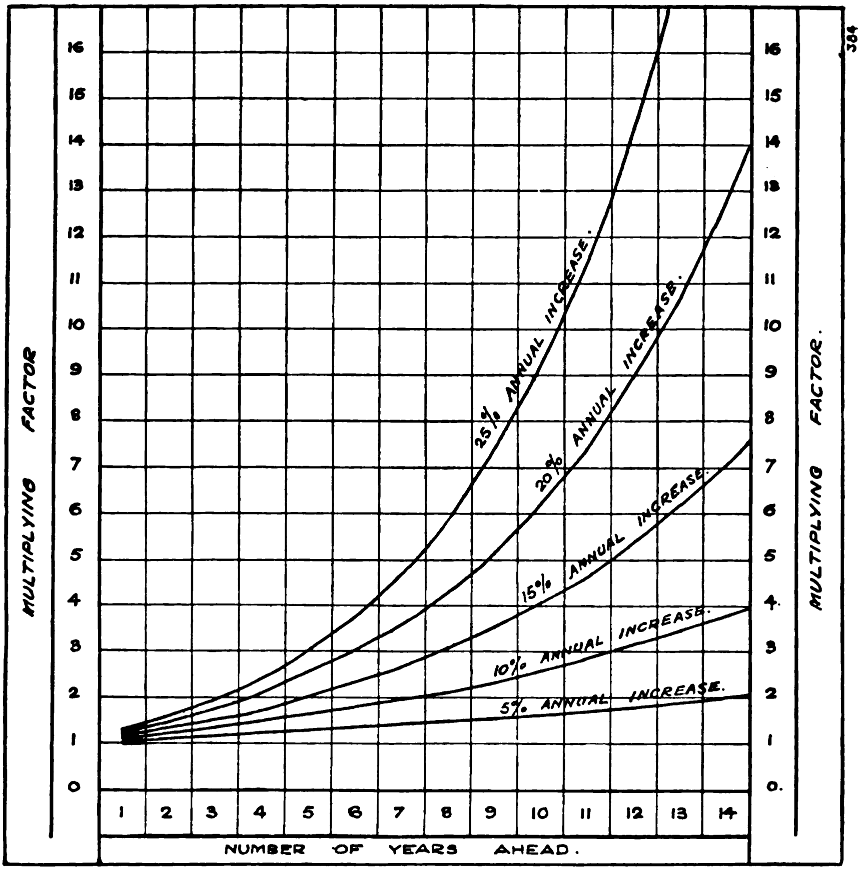
The chief reason for their extended use is that of first cost. A growing pole can be procured for from 4*d.* to 8*d.*, against an iron pole at from £1 to £1 10*s.* Further, these branch lines are seldom required to deal with more than twenty or thirty messages per day.

THE LONDON TELEPHONE SYSTEM IN 1920: A FORECAST.

By M. C. Pink,

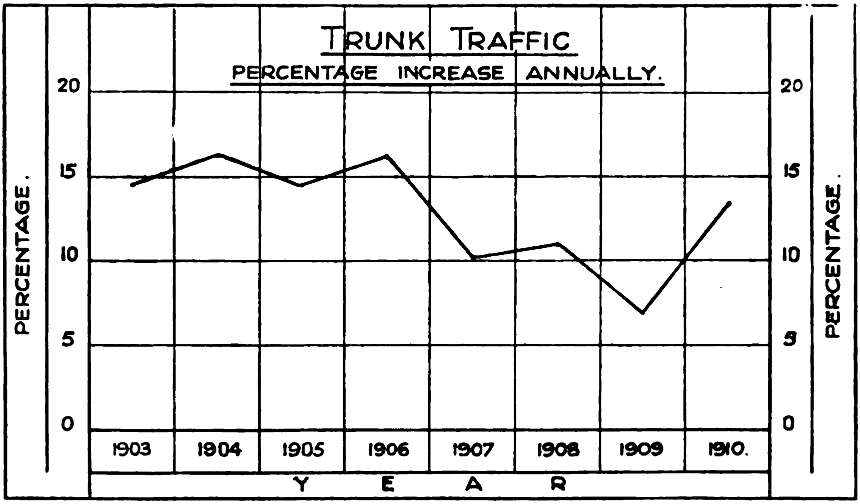
London Telephone Service.

The consideration of the probable increase in the number of telephone lines and stations in London during the next five or ten years is a matter of particular interest to all telephone men at the present juncture. It is proposed briefly to review the available data and to endeavour to forecast the dimensions of the system we shall have the pleasurable duty to provide for during the coming years.

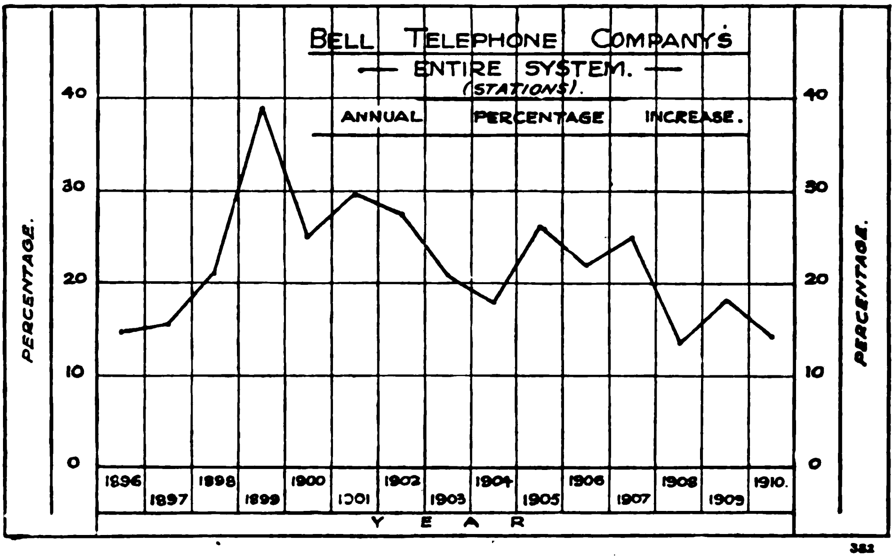


I.—Curves showing Multiplying Factors for Various Rates of Increase.

In preparing estimates of future growth a most important factor is the annual percentage increase. In many branches of telephone development this percentage is found to be fairly constant. The mathematical mind will at once perceive that a progression of this nature involves a very pronounced numerical increase; but it is as well to consider the abstract effect graphically. I has been prepared to show the multiplying factors to be applied in order to find the numerical increase of any quantity which has grown at a constant rate of increase per annum for a given number of years.



2.—ANNUAL PERCENTAGE INCREASES OF TRUNK TRAFFIC.

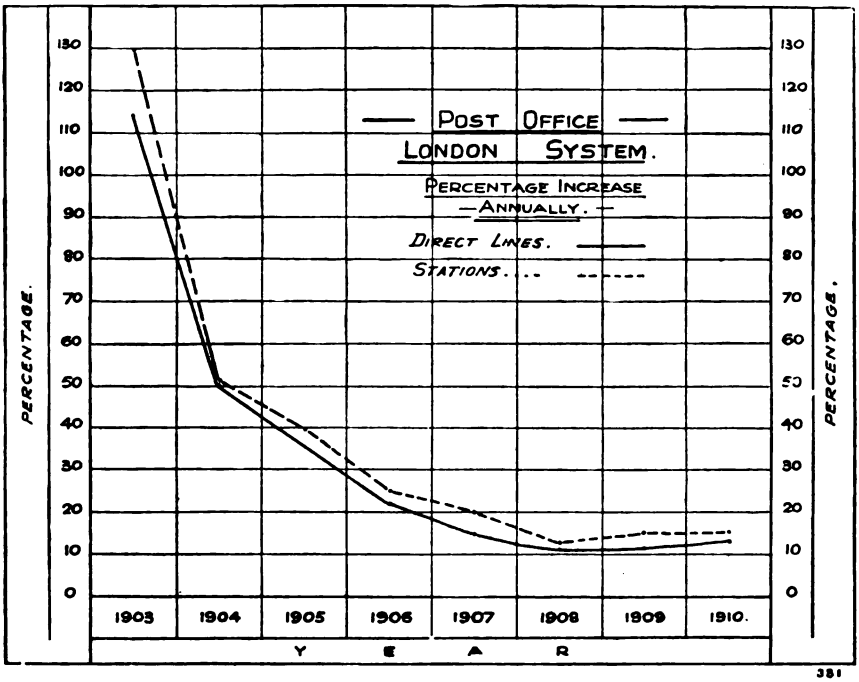


3.—ANNUAL PERCENTAGE INCREASES OF BELL SYSTEM.

The diagram will show at once that a system of, say, 10,000 lines, which is increasing at a constant rate of 20 per cent. per annum, will develop into one of 62,000 lines in ten years.

It may, however, be objected by some that in practice a constant percentage annual increase will not be achieved. In this connection we will examine the achievements of established telephone systems or portions of systems. Let us take first of all the development of trunk traffic throughout the kingdom during the past eight years, as shown in **2**.

It will be seen that although there was a drop from 1907 to 1909 the percentage rose again in 1910 almost to the level of the years 1903 to 1906, in spite of the enormous increase in the total amount of traffic handled from 11,574,229 calls in 1903 to 26,566,318 in 1910.



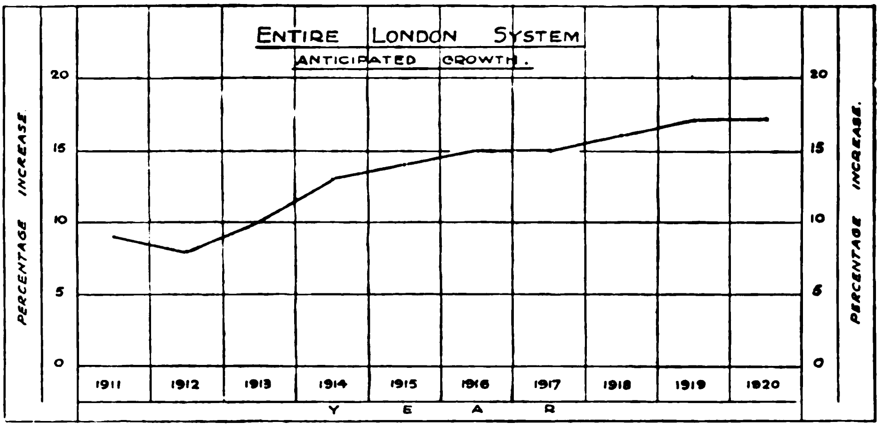
4.—Annual Percentage Increases of P.O. London System.

Now let us consider the growth of the Bell Telephone Company since the expiration of the Bell patents (see **3**).

It will be seen that the percentage in this case reached the enormous value of 38 in 1899. It was not, of course, to be expected that such a high figure could be maintained; but the diagram provides direct evidence of a possibility to maintain a very high percentage annual increase for a considerable number of years.

Having considered these two instances we will attack the question of London's telephone future. Very interesting statistics of the growth of the London system have appeared in this JOURNAL from time to time. On the basis of these statistics the curves in 4 have been prepared to show the annual percentage increase since 1903.

These curves are worthy of close attention. It will be noticed that the formation of the direct exchange line curve is remarkably regular. It is not, of course, to be wondered at that the Post Office system, springing into being as it did at a time when the British public were beginning to wake up to the uses of the telephone, should show such remarkable increases during the first few years of its existence; nor need we wonder that the initial progress, on a percentage basis, has not been maintained. The curves clearly demonstrate, however, that a critical point in the Post Office London development was reached a year or so ago, and that the rate of growth is now steadying itself to established conditions round about a figure of 12 per cent. annual increase.



5.—ANTICIPATED PERCENTAGE INCREASES OF P.O. LONDON SYSTEM.

Evidence has been produced to show that a fairly constant percentage may be counted upon for some years after the settling down of the transfer of the company to the Post Office. We may, however, go further with our optimism and predict that this percentage will not only be maintained but will also show an upward tendency. The following are some of the reasons for this optimistic view:

(1) The percentage increase in stations on the National Telephone Company's London system is of the order of 8, and is only slightly decreasing in spite of the restriction of development in certain areas since 1901 and the economies in capital expenditure due to the impending transfer.

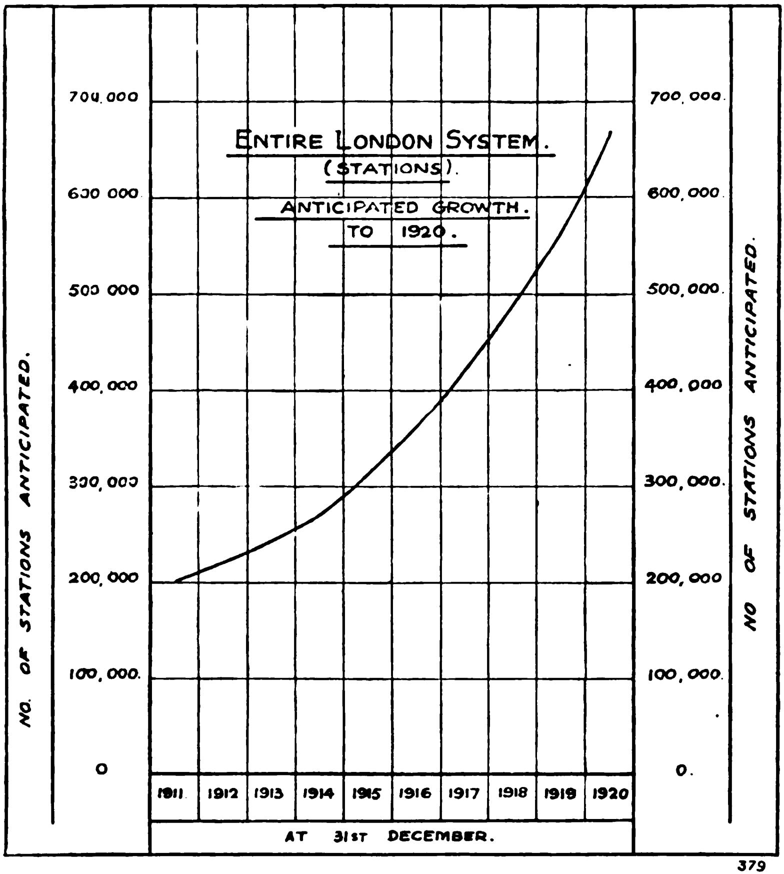
(2) The anticipated general application of measured service rates will involve—

(*a*) A marked increase in the number of exchange lines;

(*b*) A resultant increase in service efficiency, involving—

(*c*) Greater confidence in the telephone system and increased user.

(3) The anticipation that improvements in the canvassing and advertising methods in the near future will bring in more business.



6.—ANTICIPATED GROWTH OF LONDON TELEPHONE SYSTEM.

It may, it is thought, be predicted from the available evidence that the annual increases for the next ten years will be of the order of those shown in **5**.

These percentages are converted into actual numerical values in **6**, the figures including, of course, the growth of the present system of the National Telephone Company, which will soon become truly "national."

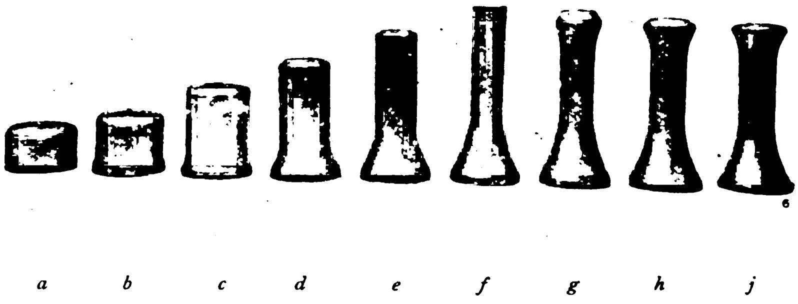
It will be seen, therefore, that a London telephone system comprising nearly 700,000 exchange stations ten years hence is no idle dream but a very real probability. There is no doubt about the demand, and if we are to meet that demand in a satisfactory manner there must be ample funds available, particularly in 1912 and 1913, for making adequate provision for expansion. It is to be hoped that all who are responsible for the administration of the service will take a liberal view of the situation, and will spare no effort to secure the healthy growth of a wonderful plant by giving it plenty of room, plenty of nourishment, and the most skilful care obtainable.

In spite of the increased application of scientific methods of recent years, many Britishers still ignore the necessity for a reasoned consideration of future requirements. It must not be the sad lot of some historian of the future to say that the Treasury or the Post Office, or both, failed to realise and provide for, the potentialities of telephony in the United Kingdom.

NEW IDEAS.*

Bell Receiver.

It is recorded in "Preece and Stubbs" that the first practical magnetic telephone was exhibited in the Essex Institute in Salem, Massachusetts, on February 12th, 1877, and as one looks at an illustration of the instrument then exhibited and compares it with one of the latest types one is struck with the comparatively small amount of change, in essential parts, which has taken place during the intervening thirty-four years, despite the large amount of money

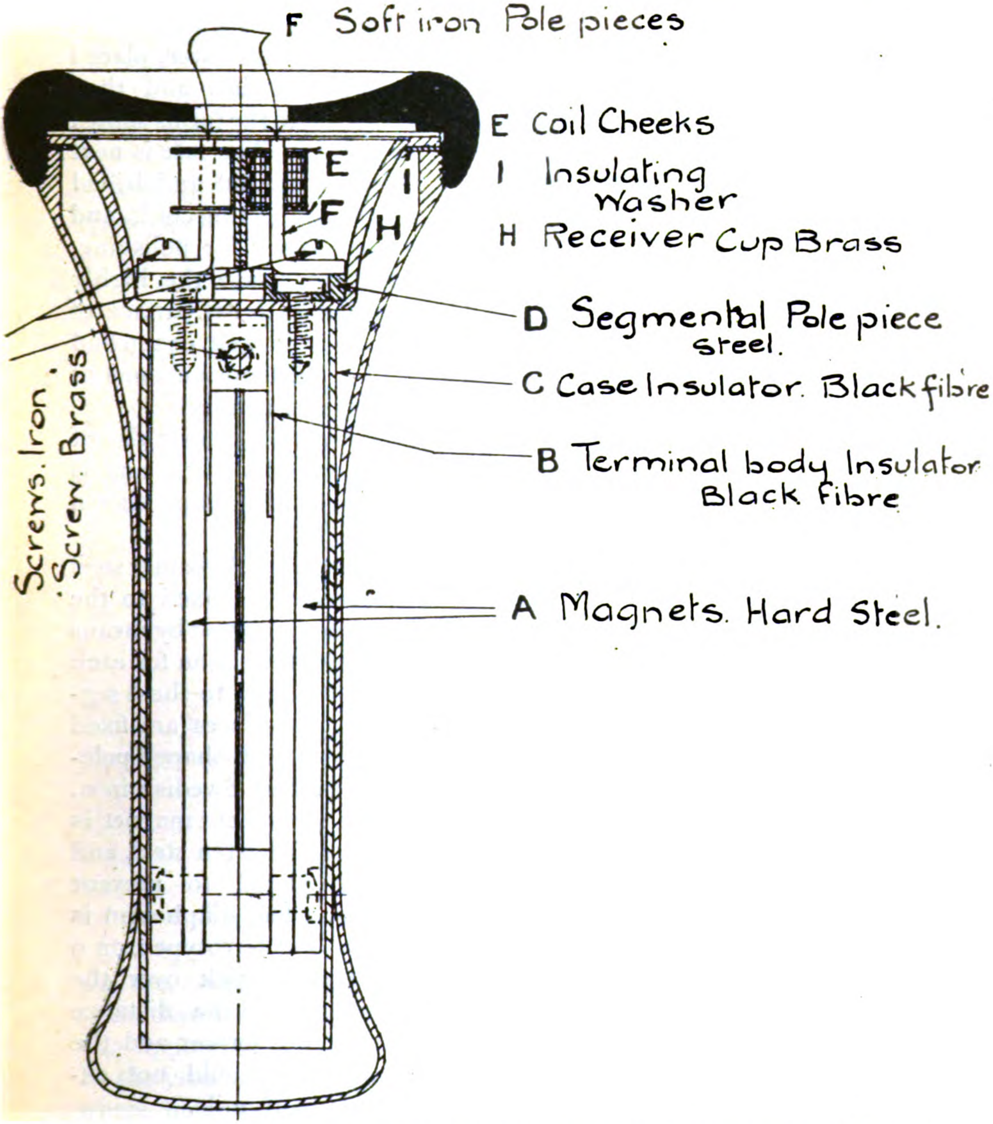


I.—Bell Receiver. Manufacture of the Brass Case.

---

[*] By the kind permission of the Engineer-in-Chief and with the concurrence of the Postmaster-General and Secretary, details of new ideas originated or adopted by the Post Office Engineering Department are published in this section for the information of all who may be interested.

and time devoted to the subject. What changes have been made have been principally in the direction of simplification of manufacture and consequent cheapness of production, and the receiver

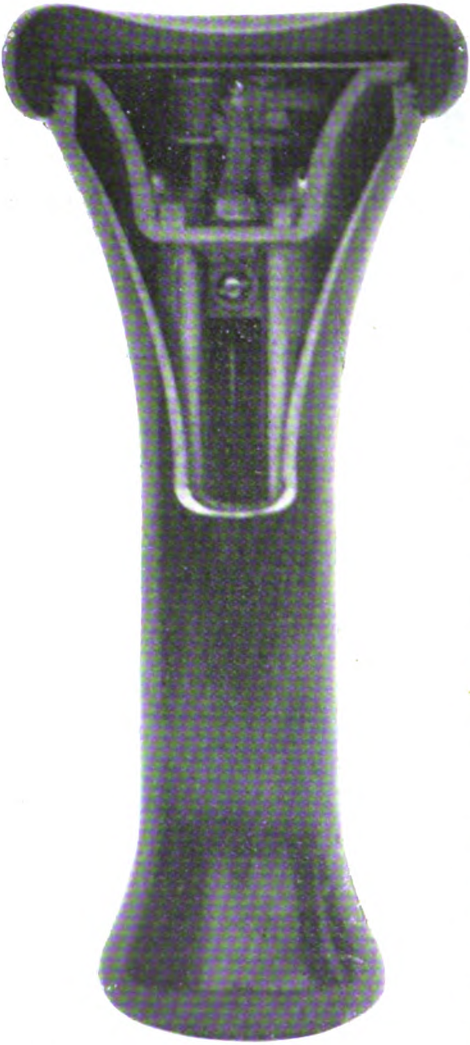


2.—Sectional View of Bell Receiver (exact size), showing Arrangement of Magnets, Pole Pieces, Coils, Receiver Cup, Case Insulator, and Brass Case.

about to be described represents the latest developments in this direction.

The receiver body is of brass, 45 mils thick, and is made in one piece.

The manufacturing process by which this is achieved is an interesting one, and the various stages are shown in 1. *a* shows the blank and first form, *b*, *c*, *d*, *e* and *f* the second, third, fourth, fifth and sixth forms. The case is then partially filled with a fluid such as a mixture of glycerine and water, placed in suitable dies, and then pressed into the forms shown at *g* and *h*. The case is next threaded, turned, and drilled for the connecting cords, and is then ready for polishing. After this stage the highly polished external surface of the body is well enamelled with a hard stove enamel of the highest quality.



3.—PHOTO (PARTLY IN SECTION) OF BELL RECEIVER NO. 1 (MARK 4001) (EXACT SIZE).

The receiver cup is also of brass, 63 mils thick, and is drawn to the shape shown in 2.

Segmental Bessemer steel pole-pieces are fixed to the permanent magnet by means of steel screws, one for each pole-piece, and to these segmental pole-pieces are fixed the coils with **L**-shaped pole-pieces of best Swedish iron.

The permanent magnet is made of Tungsten steel, and is zinc plated to prevent rusting. The diaphragm is of best soft ferrotype iron 9 to 12 mils thick over the varnish, and the distance between the former and the pole-pieces should not exceed 14 to 16 mils.

The receiver body is insulated from the cup by means of a black fibre ring, and from the magnets by a split tube of black fibre about 4 in. long.

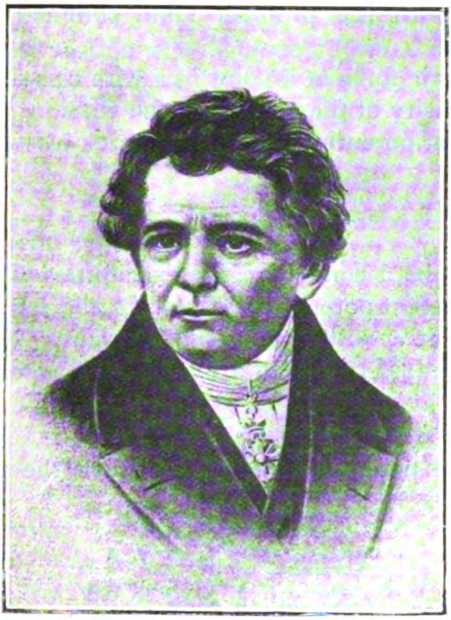
Each coil is wound with 605 turns of 4·8 mils single silk-covered tinned copper wire. The resistance of the receiver is 64 ohms, and its efficiency is 2 miles of standard cable better than the previous standard type.

2 and 3 show constructional details. The instrument will be known as Receiver Bell No. 1 (Mark 4001).

OHM AND HIS LAW.

By AND. FRASER.

GEORG SIMON OHM was born in the year 1789 at Erlangen in Germany, where his father followed the occupation of a locksmith.



GEORG SIMON OHM—1789-1854—THE GERMAN PROFESSOR WHO PUBLISHED 'OHM'S LAW' IN 1827.

On the completion of his studies at the local University he spent some time teaching in various schools until the year 1833, when he was appointed Director of the Polytechnic School at Nuremberg. In the year 1841 Ohm was transferred to a professorship at Munich, where he occupied the chair of physics from 1852 till his death two years later.

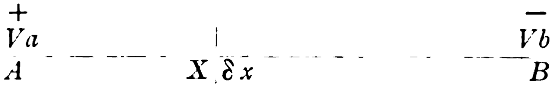
During his early collegiate life Ohm was greatly hampered in his scientific work by the absence of those two essential factors to success—time in which to carry out investigations, and suitable apparatus with which to make them. Yet, in spite of the difficulties with which he had to contend, this German student was enabled, from the results he obtained, to enunciate the law which is now universally known by his name.

It is true that Pouillet independently discovered the same law experimentally; but Ohm attacked the question from the *à priori* standpoint and at an earlier date.

When Ohm's thoughts were first directed to the problem of electric conductivity, the beautiful theory of Fourier on the conduction of heat was filling the minds of the physicists of his time, and it occurred to Ohm that the method employed by Fourier in the case of heat might be equally applied to electricity and, starting from the same hypothesis, he was led to the same results, which he found could be expressed by an exactly similar formula.

In dealing with the problem Ohm confined his attention to three things:

(1) The electric force at a point in a wire carrying a current.
(2) The intensity of the current in the wire.
(3) The fall of potential along the wire.



(1) Let $A\,B$ be a conductor, the extremities of which are maintained at the constant potentials Va and $V\,b$ and let F be the electric force at the point x acting from left to right. Now, if a unit of + electricity is transferred from x through the small section $\delta\,x$, the work done is—

$$\delta\,W = F \times \delta\,x.$$

But if $\delta\,V$ is the potential difference between the two faces of the section $\delta\,x$,

$$\delta\,W = -\,\delta\,V.$$

$$\text{Hence } -\,\delta\,V = F\,\delta\,x,$$

$$\text{from which } F = -\,\frac{\delta\,V}{\delta\,x}.$$

Now when the section $\delta\,x$ is taken smaller and smaller $-\,\frac{\delta\,V}{\delta\,x}$ becomes, in the limit, the force at x in the conductor $A\,B$, and may be represented by $-\,\frac{d\,V}{d\,x}$.

In the second case (2) it is assumed that the quantity of electricity passing any section of the conductor is proportional to the force acting at that point and also to the cross-section S of the conductor. Expressing this in terms of the flux c per second,

$$c = -\,k\,S\,\frac{d\,V}{d\,x},$$

where k is a constant.

Now, in order that there may be no accumulation of electricity at any section, c must be constant; and, therefore, the force $\frac{d V}{d x}$ at the point must likewise be constant. The flux c becomes, under these conditions, the strength of the current.

(3) The statement that the ratio $\frac{\delta V}{\delta x}$ is the same at all parts of the circuit implies that it is independent of x, or, in other words, that no matter at what part of the conductor we take the small section δx the same potential difference will exist between its faces provided that δx is the same in each case.

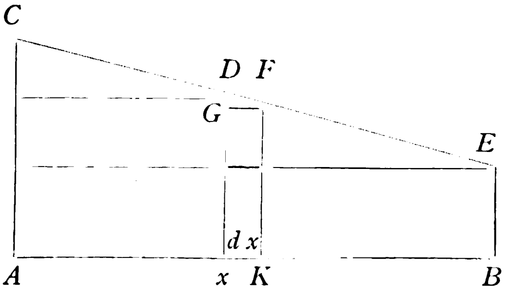
Again, in going from A to B the decrease of potential per unit length is $\frac{V_a - V_b}{l}$, where l stands for the length $A B$; and therefore the potential of any section at a distance x from A will be—

$$V_x = V_a - \left(\frac{V_a - V_b}{l}\right) x,$$

from which we get the relation—

$$\frac{V_a - V_b}{l} = \frac{V_a - V_x}{x}.$$

Consider the following diagram—



If $A C = V_a$, $D x = V_x$, $B E = V_b$, and $A B = l$, it is clear from the geometry of the figure that—

$$\frac{A C - B E}{A B} = \frac{A C - D x}{A x} = \frac{D x - F K}{x K},$$

$$\text{or } \frac{V_a - V_b}{l} = \frac{V_a - V_x}{x} = \frac{\delta V}{\delta x} = C,$$

which may be taken as a measure of the current flowing in the wire.

This is Ohm's law for the conductor under consideration, in which l may be regarded as a measure of its resistance. To make the law applicable to any conductor the specific conductibility K must be taken into account as well as its cross-section S. Instead of κ, it is more usual to consider its reciprocal $\frac{1}{\kappa}$ or ρ, which is termed its specific resistance. We may therefore re-write the expression—

BIOGRAPHY

$C = -\kappa S \frac{dV}{dx}$ as

$C = \frac{V_a - V_b}{\left(\frac{l\rho}{S}\right)}$ (neglecting the negative value of the differential dV),

or calling the quantity $\left(\frac{l\rho}{S}\right)$, R.

C (the strength of current) $= \frac{V_a - V_b}{R}$, which is the ordinary form of the expression.

In the first attempts at the experimental verification of his law, Ohm was confronted with the difficulty of obtaining a battery capable of maintaining a constant potential difference between the ends of the conductor; and he accordingly took advantage of Seebeck's discovery of thermo-electricity, which had been made a few years previously. The junctions of a bismuth copper couple were kept at constant temperatures of 100° and 0° C. respectively by using steam and ice; this gave a constant weak E.M.F. and had an exceedingly small internal resistance. Different lengths of copper wire could be included successively in the circuit by placing their ends in mercury cups and observing the torsion required to bring a magnetic needle back to the meridian from which it had been deflected by the passage of the current in the wire under observation.

In 1827 Ohm published the results of his investigations, but the importance of his discovery was not appreciated until the year 1841, when the Royal Society of Great Britain awarded him the Copley Medal. At a later period a rigorous investigation into the truth of the law was carried out by Clerk Maxwell and Chrystal, who showed it to be true even when the current in the conductor was so strong as to almost fuse it.

Such, then, was the man and his law—that law which has been the electrical *pons asinorum* of so many students in the past, and will be of many who have yet to come. The records of technological examinations are strewn with almost every possible misconception of it. Even the Yankee $\left(\frac{E}{C\,R}\right)$ mnemonic has not saved the tyro from coming to grief in his application of it. And here it may not be deemed an inappropriate conclusion to quote the words of a student who, at a time when our genial Chief Electrician was the examiner, in answering the question, "What is Ohm's law?" wrote,

"Ohm was an intelligent investigator of ohms and volts, whose name will be handed down to *fratternity*."

NEW FIRE ALARM SYSTEM FOR THE G.P.O. BUILDINGS.

By E. V. SMART.

WHEN new buildings are being erected or drastic alterations to old ones are taking place, *then* is the best time to review systems with the object of installing the best and most up-to-date arrangement in an economical manner. With this in mind, the fire alarm system of the G.P.O. buildings was recently examined and a change decided upon. A brief description of the system resulting will be given.

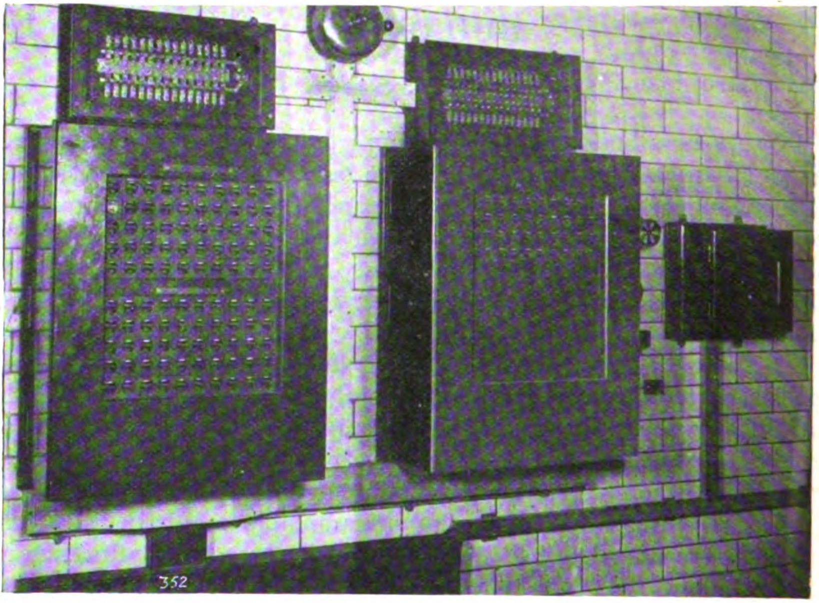
It is not for engineering officers to dilate on the terrors of fire, but to act upon well-recognised principles to prevent, as far as lies within their power, loss of life and damage to property. If information of a fire were given to capable officers early enough, very few fires would become serious. Post office buildings do not contain, as a rule, large quantities of highly inflammable material, and consequently are not likely to be burned out if this early intimation is given. Plenty of exits and broad passages are features of the G.P.O. buildings, and the various staffs have instructions from their superiors how to act in case of fire, so, having to deal with fires chiefly from the point of view of preserving property, the essential point aimed at was to get an intimation with the exact locality of the fire to the trained firemen at the earliest possible moment.

Press-buttons enclosed in brass circular boxes having glass fronts are placed in conspicuous positions in all parts of the buildings. Every position is represented by an eyeball indicator in each fireman's room.

On the depression of a press-button the eyeball indicator corresponding to the position drops and the fire-bell rings.

The firemen immediately push the plungers of the electro-magnetic key indicators and go to the fire. The action of pushing the plunger stops the ringing of the fire-bell and causes the electro-magnetic key indicator, which normally is "all black," to show "black and white"; the eyeball indicator is not affected, still remaining down. Thus, while the firemen are attending to a fire call, there are two indications in their rooms, one to show that they have been called to a fire, and another showing the exact point to which they have gone.

The system thus enables four or five trained firemen to arrive at the call-point at times varying from a few seconds to a minute or two. The "home" fireman, or the fireman in the building where the call is given, will be at the fire first, and the times of the other firemen will vary as the distance to the point varies. The great feature is that each fireman is informed instantly the press-button at any point is pushed where there is a fire, and he proceeds immediately and directly to that point.



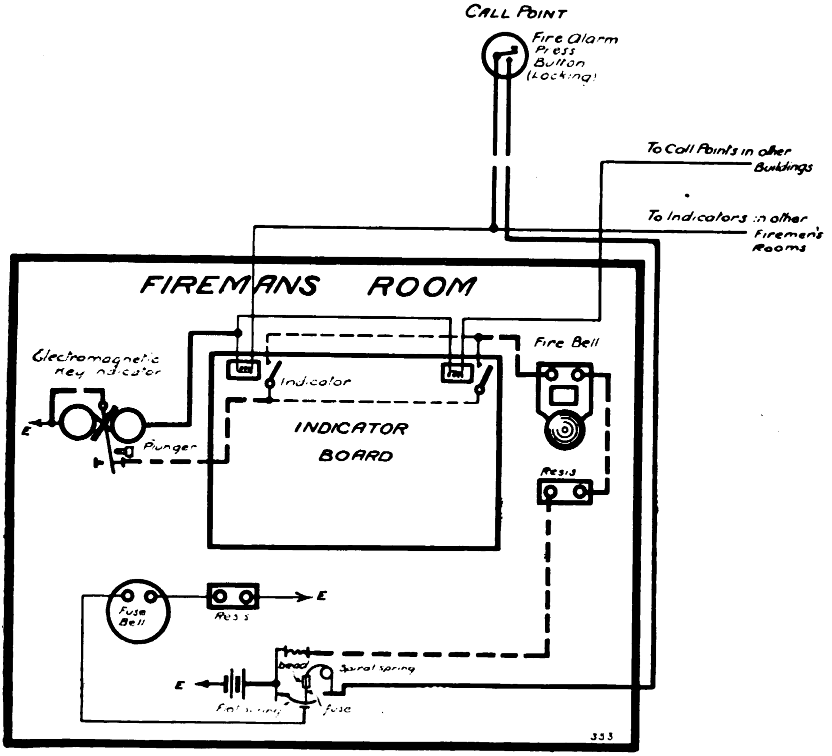
I—G.P.O. Fire Alarm System. Equipment in Fireman's Room, showing Call received.

Upon arrival there, should the fire appear serious enough to warrant a metropolitan brigade call, the fireman calls the Cannon Street Fire Brigade Station on a "fire" telephone, several of which are placed about each building. It is a direct circuit to the brigade station, and the telephones are in bridge upon the circuit.

When the fire has been subdued the "home" fireman releases the press button, breaking the circuit and allowing the indicators—eyeball and electro-magnetic—to go to their normal condition.

Everything is now again in order for the next call.

The electrical arrangement of the circuit is very simple :


CALL POINT
Fire Alarm Press Button (Locking)
To Call Points in other Buildings
To Indicators in other Firemen's Rooms
FIREMANS ROOM
Electromagnetic Key Indicator
Plunger
E
Indicator
INDICATOR BOARD
Fire Bell
Resis
Fuse Bell
Resis
E
E
bead
Spiral spring
Flat spring
fuse
333

2—G.P.O. Fire Alarm System. Circuit Arrangements.

A 24-volt power lead is taken to a fuse-board on which fuses are placed in the lines *to* the call-points. The fuses are of the alarm indicator type; the fuse is in tension between a spiral spring connected to the call-point side and a flat spring on the battery side. The blowing of a fuse from any cause gives the springs their freedom ; the flat spring completes a bell circuit, giving the warning that a fuse has gone, and the spiral spring throws the bead vertically upwards, indicating which fuse has gone. This is a very necessary precaution, as otherwise not only may a call-point circuit be out of order, but it may be rendering the whole system temporarily useless. When the fuse bell rings, the "home" fireman proceeds to the call-point as for a fire, for the fuse giving way may be due to an earth on the return wire from the call-point. A disconnection is not provided against, as the system is based on the existence of a disconnection in the line normally. It is possible to devise a system where disconnections and earths are detected, but it must necessarily be more complicated, and as the firemen prove their circuits and examine their tackle frequently, the possibility of a disconnection existing when a circuit is required for an actual fire is very remote. The lines *from* the call-points divide, each branch of the divided portion passing through an eyeball indicator and an electro-magnetic key indicator. The electro-magnetic indicator is common to all incoming circuits.

The current passing through the indicator key when a press-button is pushed is not sufficient to actuate it. This condition is necessary, as the fire-bell circuit is completed through the tongue of the indicator key in its normal position. When, however, the plunger of the indicator key is pressed the bell circuit is broken, and the armature is placed close to the cores. The current is capable of *holding* the armature in that position. Fixed to the top of the armature spindle is a black and white disc placed under a black sectored grid. Normally the black of the disc fills up the gaps in the grid, but when the armature is close to the cores the white of the disc shows through the gaps.

3—G.P.O. FIRE ARRANGEMENTS. NORTH SIDE OF KING EDWARD VII BUILDING, SHOWING FIRE ESCAPE, BALCONIES, AND LADDERS.

Being assured that there is a minimum loss of time in advising the firemen, it is satisfactory to know that the firemen, although not moving at exactly the same rate as electricity moves, can supplement that early advice with powerful measures, so quickly applied, that it would appear almost impossible for a fire in the G.P.O. buildings to assume serious dimensions. A fireman can have water at 75 lb. pressure or thereabouts playing on the fire within 15 seconds of arriving at a call-point. There are about 150 call-points in the buildings, and hoses are placed at the same points. The hose is so coiled up, in the shape of a figure 8, that as the fireman runs towards the fire with the nozzle it easily and swiftly unfolds—there is no fear of tangles. In the King Edward Building the water is fed from a pipe-ring on the sub-basement floor where tees which rise vertically are taken off. The call-points are numbered to agree with these tees. Call-point 7, second floor, is vertically over call-points 7 on the first and ground floors, and vertically under call-point 7 on the second, third, and fourth floors. This simple method of naming and identifying points adds to the efficiency.

The water is kept at high pressure by a pumping-engine, but if that should fail, an injector worked on the hydraulic principle would be used. In case of leaks or for other purposes the pipe carrying the water under high pressure can be so divided as to isolate the defective portion and still allow the other portion to be used.

MECHANICAL ANALOGIES APPLIED TO RADIO-TELEGRAPHY.

By F. W. Davey,
Engineer-in-Chief's Office.

The equations below are not germane to the present article; they are given in order that those who wish to compare the fundamental mathematical equations involved in radio-telegraphy with the statements in the text may do so. The article, however, may be read without any reference to these equations.

Velocity (v) per second of propagation of wave motion in any medium $= n\lambda$;

where $n =$ frequency of oscillation per second,

$\lambda =$ wave length.

Velocity of propagation in the ether $= 3 \times 10^8$ metres per second

In an electrical oscillating system, if—

$K =$ capacity in farads,
$L =$ Inductance in henries,
$R =$ resistance in ohms,

$$n = \frac{1}{2\pi}\sqrt{\frac{1}{KL} - \frac{R^2}{4L^2}},$$

from which it will be seen that the condition for the quantity under the root sign to be real is that R shall be less than $\sqrt{4L/K}$; if R exceeds this amount, the electrical system will not oscillate.

If R be negligible, then—

$$n = \frac{1}{2\pi\sqrt{KL}}$$

From this and the equation $v = n\lambda$, it follows that, for a radio-telegraphic installation where resistance is generally negligible so far as its effect on the frequency of oscillation is concerned,

$$\lambda = 3 \times 10^8 \times 2\pi\sqrt{KL}.$$

If k and $l =$ capacity and inductance respectively of a particular oscillating system, and $k_1\ l_1$ = capacity and inductance of another oscillating system, the condition for resonance between the two is—

$$k_1\ l_1 = k\ l.$$

In one's early studies of electrical phenomena, mechanical analogies were frequently of use in giving a material conception of the principles involved; the well-worn, but nevertheless useful, hydraulic analogy of the flow of water from an elevated tank to one at a lower level to illustrate electromotive force, current and resistance, was, and probably is, familiar to us all. It cannot be claimed that such analogies are complete, but as aids to the formation of a conception of the somewhat obscure processes involved in electrical phenomena they are not to be despised, least of all in the principles involved in the science of radio-telegraphy. Such, then, must be my apology to those who may regard the analogies as crude; what analogies are otherwise? The science of radio-telegraphy is undoubtedly one best suited for higher mathematical treatment, if dealt with only for those possessing the necessary mathematical knowledge; even to these, it is thought, the analogies cited, although they may not be of much assistance, may prove interesting and helpful. An attempt will therefore be made in the present article to illustrate by mechanical analogies the processes involved in the generation, transmission and reception of high-frequency electrical oscillations, by which means radio-telegraphy is effected.

There are two kinds of energy—potential and kinetic; matter may possess potential energy (energy at rest) on account of its position, and possesses kinetic energy (energy in motion) when it is in motion. A pile-driver weighing w lb. possesses wh ft.-lb. of energy when elevated h ft. above zero level. The weight in its descent has its energy converted from the potential to the kinetic kind. At the moment of contact with the pile at zero level, neglecting losses by friction, it still possesses wh ft.-lb. of energy, but the energy is wholly kinetic; if v is the velocity of the weight at that instant, its kinetic energy is equal to $\frac{wv^2}{2\ g}$, where g is the acceleration of gravity at the particular point of the earth's surface. So in all mechanical systems where energy changes rapidly from one kind to another, or alternates between the two kinds, a decrease in energy of potential kind is accompanied by an increase in kinetic; likewise a decrease of energy of kinetic kind is often accompanied by an increase of potential. When either is zero the other is a maximum.

A charged condenser is the seat of a certain amount of energy, depending in amount upon the capacity of the condenser, and the difference of potential to which its plates are charged. If it were possible to isolate completely the condenser, and thus preclude the possibility of slow dissipation losses, the energy of discharge would be the same in amount were the discharge to occur at one hour, or one million hours after it had been charged. Although the condenser is a seat of energy, the energy is at rest, ready to do work; it is, therefore, of the potential kind—of the same kind as that of the pile-driver elevated above zero level and kept there until released. When the condenser is discharged it is no longer a seat of energy; the potential energy it possessed has been dissipated, and during the process of discharge a certain amount of work has been performed; electro-magnetic, lighting, heating, or chemical effects will have been produced in the discharging contrivance. Now, kinetic energy is the necessary concomitant in the process of the performance of work of any kind; the potential energy of the charged condenser has, therefore, been converted into kinetic during the process of discharge, in the same way as the potential energy of the pile-driver has been converted into kinetic before work is performed upon or in the pile which it drives. The discharge of the condenser, whether by the piercing of a dielectric or by a current flowing in a conductor connected to the two plates, gives rise to phenomena associated with electro-magnetics. It will therefore be seen that potential energy is associated with electrostatic, and kinetic energy with electro-magnetic phenomena.

Both kinds of phenomena are evidenced across a vacuum without any tangible intervening medium; repulsion occurs between two like charged bodies; the presence of matter between two plates of a condenser is not essential for the mutual action between the two plates. Again, the presence of matter is not essential for the mutual electro-magnetic action between two conductors carrying currents. If, however, matter be introduced between the plates of the condenser, or between the two conductors, the phenomena will vary in amount with the kind of matter introduced. We have therefore to admit that the intervening medium in both cases enters into the action between the two bodies. The dielectric constant of the intervening medium in the former and the permeability of the medium in the latter express the amount by which the action is modified as compared with some arbitrary standard. It is therefore only logical to conclude that in the case of action across vacuum there is some medium intervening by means of which the energy necessary to produce the action is stored or transmitted as the case may be, and that during such storage or transmission the structure of the medium is modified in some peculiar manner corresponding to the particular form of energy, potential or kinetic, which is present. We have only to turn to the phenomenon of light for a forcible illustration of action between bodies at immense distances and the transmission of energy through space. The light of stars at distances far beyond the limits of the finest instruments of precision and of mathematical calculation is transmitted to this earth. There is action between the matter of the star and the matter of the eye, and a corresponding transmission of the necessary energy, to which phenomenon we give the name of light, and to the medium by which the energy is transmitted through space we give the name of the ether. How shall we define this medium? The question is best answered by another question—How shall we define any piece of matter? Presuming that one totally unacquainted with iron asks for a definition of iron, we at once commence by describing the characteristics of iron; it is of certain weight, structure, hardness, etc.; and to the substance possessing these characteristics we give the name of iron. We define matter of all kinds by its characteristics; that is, it evidences itself to us by affecting our senses in certain ways, and when our senses are affected in these certain ways a distinctive name is given to the particular piece of matter which produces the sensations; a matter of human convention. Note that we are not able to define matter absolutely; so, in the same way, when a definition of the ether is demanded, we summarise its characteristics: that it is the medium whereby certain forms of energy, which are evidenced to us in some particular manner, are transmitted from one place to another, and to that which transmits these forms of energy we give the name of the ether. There is as much absolute proof that a medium exists in which the whole of matter is immersed as there is of the existence of matter itself. It is an axiom that the eye only sees that which the eye brings power to see; everything around us, even we ourselves, are evidenced by sensations, and sensations alone.

We have seen that in the case of a charged condenser the ether can be put into a state corresponding to potential energy; its structure is modified in some peculiar manner corresponding to this form of energy, and also in the case of electro-magnetic action its structure can be put into a state corresponding to kinetic energy; morever, during the discharge of the condenser, the structure of the medium corresponding to one form of energy is altered in the process of discharge to correspond with the other form of energy. In other words, the energy present in the medium, and hence the corresponding modification in the structure of the ether, can alternate between the two kinds associated with matter—potential and kinetic. In the case of matter energy is stored by means of stress exerted upon the matter, resulting in a strain in the matter. Energy is transmitted in matter by the particles of matter transmitting these stresses and strains to contiguous particles. We can therefore assume that something analogous occurs in the ether by which energy is stored or transmitted.

We will now consider the kinematics of the method of transmission in the ether by considering the analagous transmission of energy in something more tangible than the ether. The waves in water are known as transverse waves. It will be observed that during the progress of such waves there is no lateral translation of the mass of the water; the wave, consisting of an elevated portion of water and a corresponding depression, travels; although no lateral translation of the medium in which the wave is propagated occurs, yet energy is transmitted laterally from one part to another by means of the wave. Taking the level of smooth water as an arbitrary level to which to refer the kind and amount of energy in the particles, and neglecting the intrinsic amount of energy which the particles possess at different periods of wave propagation owing to rotation of the particles at these periods, at any instant the mass of water forming the crest of a wave can be said to possess positive, and that forming the base negative, potential energy. These masses, however, are not in a stable condition; that at the crest falls and that at the base rises, and in so doing the potential energy of the mass is converted into kinetic, reaching maximum velocity, and hence maximum kinetic and zero potential energy, at the zero level. The kinetic is then converted into potential energy, which reaches a maximum at the crest and base of a new wave. All these actions are produced by parts of the mass transmitting stresses to adjacent parts with consequent strains. It does not require much observation to see that, whatever action is taking place in a particular part of the mass, the tendency of this action in contiguous parts is to increase the kind of energy in which that part is increasing. For instance, the part which is approaching the formation of a crest, in the process of its elevation causes the further depression of that part approaching the formation of a base by elevating the intervening parts between crest and base; this elevation in the case of that part below zero level increases, and in the case of that part above zero level decreases the kinetic energy, with the corresponding decrease or increase of the potential energy. A word of warning should perhaps here be added, inasmuch as the principles of wave motion outlined above do not express the whole of the processes involved in wave propagation. The potential and kinetic energies in a particular particle are co-existent, and reach maximum and minimum values at the same times; in fact this condition is essential for wave propagation. The consideration, however, of the rotation of the particles themselves, and the consideration of the energy of the particles without reference to the arbitrary zero level which we have premised, both of which are involved in the actual processes, are too complicated to admit of treatment from the simple point of view of analogy. It is herein that the analogy cited, in common with all analogies, fails. With this reservation, therefore, we can say, from our present point of view, that the principle of wave motion consists of an alternation of the kind of energy in the mass, and also that energy is transmitted from one place to another by means of these peculiar alternations in the form of energy in the medium, and the consequent stresses and resulting strains.

It will be observed that the motion of the particles is in the perpendicular direction, and that the transmission of energy is in a horizontal direction; or, as is generally expressed in regard to wave motion of this kind, the wave motion is at right angles to the direction of propagation. It may also be observed that the wave fronts, *i. e.* the particular perpendicular chain of particles below a crest, are normal, or are at right angles, to the surface.

If we imagine the alternations between the two kinds of energy constituting wave motion in water, to occur in the mass, and not at the surface only of the water, we can form some picture of the process by which energy is transmitted in the ether. The alternating stresses and resultant strains in the ether, consequent upon alternations of potential and kinetic energy being impressed at a certain point, produce stresses and resultant strains of opposite kind in contiguous parts, giving rise to wave motion and its consequent transmission of energy.

To every medium whereby energy can be so transmitted there is a certain definite velocity of propagation, which depends upon the characteristics of the medium. In the case of the ether this velocity is found experimentally to be 3×10^8 metres, or, approximately, 186,000 miles per second. Turning again to our water analogy, forces are impressed which produce waves. Take one particular wave and follow its course for one second; a certain number of waves will then intervene between us and the particular wave under observation; mark this number. If we measure the distance between the crests of two contiguous waves—that is, the wave length—and multiply it by the number of waves intervening between us and the particular wave, this will give us the distance the original wave has travelled; or, as is ordinarily expressed, the velocity per second of propagation is equal to the product of wave length and the number of waves radiating per second. It should, perhaps, be noted that wave length in any medium can be defined as the distance between two contiguous portions of the medium, which, during wave propagation, are in identical condition in regard both to kind and sign of energy.

It will be remembered that we have already pointed out that the energy associated with a charged condenser—that is, with electrostatic charges—is of the potential order, and that the energy associated with electro-magnetics is of the order of kinetic. If, then, alternations of these two kinds of energy can be produced at a certain point, energy will be transmitted in the ether to a distance, in somewhat the same manner that energy imparted to a mass of water is transmitted from one place to another. Let us consider the manner of producing the necessary alternations by considering another mechanical analogy. Imagine a weight attached to the lower end of a spiral spring which at its upper is attached to a rigid support. Stress is exerted upon the system by pulling the weight down and extending the spring, or pushing it up and compressing it, and then releasing it. The weight will then perform a certain number of oscillations per second; or, referring again to our water analogy, the energy of the system will alternate in kind between potential and kinetic, in the same manner as the particles of water in their up-and-down motion did in the propagation of a wave. Now, the number of oscillations per second which the system will make, or the number of alternations in the kind of energy that will occur, is dependent upon two factors—the resilience of the spring and the inertia of the weight; by varying one or both of these the number of vibrations per second, and hence the time period of oscillations, will vary correspondingly and according to some definite law. The time period of oscillation can be varied in another manner. Hitherto we have neglected friction. Suppose the weight to be immersed in a viscous fluid—treacle, for instance—the time period will not only be longer, but the number of oscillations performed per second will consequently be much less than formerly. Moreover, the ratio of amplitude of the second to the amplitude of the first oscillation under these conditions will be much less than was the case when the weight oscillated in air. The resistance of the fluid to change of shape, resulting in friction upon the mechanical system, has damped the oscillations; it will readily be seen that when the friction exceeds a certain amount, the weight will not oscillate at all, but will slowly return to its position of equilibrium. The motion is completely damped and is now aperiodic. With damped oscillation some function of ratio of the amplitude of the first to that of the second oscillation will express the amount of damping that occurs. This function is known as the decrement factor. Suppose an electrical system to be composed of a condenser in series with a conductor which, from its geometrical form, possesses induction, and, from its nature as a conductor, resistance. We have here the electrical counterpart of our mechanical system in which damped oscillations result from a force impressed upon it. The capacity of the condenser corresponds to the resilience of the spring, the function coupled with potential energy, the inductance of the conductor to the inertia of the weight, the function coupled with kinetic energy, and the resistance of the conductor to the friction of the system, the function coupled with the damping. The number of electrical oscillations per second will depend mainly upon the two factors, capacity and inductance, just as in the mechanical system they depended upon the mechanical equivalents, resilience and inertia; and will be modified by the presence of resistance as in the mechanical system the oscillations were modified by friction. Moreover, the resistance, as in the mechanical system, must not exceed a certain critical value for oscillations to occur. When an electrical force is impressed upon this system electrical oscillations will therefore be generated if the amount of resistance does not exceed this critical value. Moreover, the less the value of the resistance the greater the number of oscillations that will occur and the greater will be the ratio of the amount of electrical disturbance of one oscillation to the amount of that immediately preceding it. Confining ourselves to spark radio-telegraphy, as distinct from continuous radiation systems, such as the Poulsen, the electrical force is impressed by means of a spark gap across which an electromotive force is built up before the dielectric gives way to provide an electrical oscillating circuit—that is, an electrical force is impressed and then the system is released and left to oscillate. In the continuous radiation system electrical forces are impressed in a somewhat different manner, but the succeeding processes which we are illustrating are the same. The oscillating circuit of the spark system then consists of the spark gap (whose resistance during oscillation is not more than a few ohms), a condenser and a conductor having inductance and resistance all in series. About the conductor the medium, which we call the ether, will have impressed upon it energy alternating between the potential and kinetic forms. The condenser is charged (potential energy) then discharges (kinetic energy), but—because of the electrical inertia in the system—overshoots the zero position, and the kinetic energy of discharge is converted, in part, into potential energy, opposite in sign to the original form of potential energy. Another discharge occurs, and the processes are repeated until the electrical oscillations are damped out by the resistance. How, then, are these alternations between potential and kinetic energy impressed upon the ether in such a manner as to give rise to wave propagation? It is purely a matter of the time occupied in the process. When a circuit carrying a current is broken the whole energy surrounding the conductor, that is, the electro-magnetic field, collapses into the system, and, if sufficient in amount, will be evidenced at the break by a spark. This collapse of energy from the ether into the conductor is due to the slowness with which the electrical change takes place on account of the damping character of the resistance, which, in ordinary circuits, greatly exceeds the critical value at which electrical oscillation ceases. When, however, the time occupied is small, part of the energy, instead of collapsing into the system, will radiate into the ether in the form of waves. Let us turn again to our water analogy. Suppose a pointed stick to be slowly immersed in a mass of water, and then to be slowly withdrawn; no wave motion is brought about; the whole energy expended in the process is frittered out into heat which is dissipated in the mass of the stick and the water; this is the mechanical analogy of the ordinary modification of the structure of the ether produced by a conductor in which the electrical changes are slow, and therefore non-oscillatory in character.

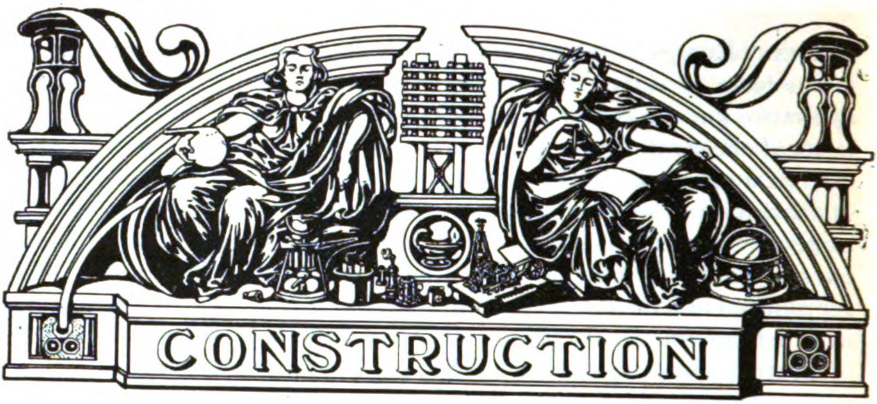
Suppose now the stick to be plunged quickly into the water; part of the energy so expended is radiated in the form of waves, and is transmitted to a distance by means of the waves. This is the mechanical analogy of the modifications of the structure of the ether which produce wave motion when electrical changes are produced in an oscillating electrical system. Take any one wave radiated by the action of plunging the stick; the height of the crests above zero level will, neglecting friction losses, decrease in the same ratio as the radius of the circle which the wave makes about the point of origin increases: for this reason the entire circular wave possesses only a certain amount of energy; as it spreads out the energy is spread over a longer line, and as the length of that line is directly proportional to the radius of the circle, so the energy in any particular small part of the line must vary inversely as the radius. By this analogy the principle will be seen which determines the law that the strength of the received signals, or in other words the amplitude of the electrical oscillations, varies inversely as the distance between the sending and receiving station. It may here be remarked that the ether, on account of its perfect elasticity, offers no resistance to wave motion as does water. The only damping factor with electrical waves is the resistance in the originating system.

Before leaving the subject of wave propagation it may be opportune to deal with the question of wave length in connection with a radio-telegraphic installation. It has already been stated that the velocity of propagation of wave motion in the ether is 3×10^8 metres, or 186,000 miles per second, and we have also seen how the velocity of propagation is equal to the product of frequency of oscillation and wave length. The frequency of electrical oscillation has been shown to be, neglecting friction, a function of the capacity and inductance of the system. Therefore as wave length is the ratio of velocity of propagation to frequency of oscillation, the adjustments of a radio-telegraphic installation may be expressed as a wave length in units arbitrarily chosen. For instance, when a radio-telegraphic station is said to work on a 600-metre wave, we mean that the capacity and inductance of the oscillating system are so arranged as to produce a frequency of oscillation that the ratio 3×10^8 to that frequency is 600.

We have seen how electrical oscillations are produced in an electrical system, how energy is radiated from the system, and the manner of transmission of the energy through the ether. Before proceeding to the reception of electro-magnetic waves, it will be of advantage to consider the principle of electrical resonance, as this principle is applied both in transmitting and receiving apparatus. Turning again to our mechanical oscillating system of spring and weight; if a small force be impressed upon the system at the same frequency as the natural frequency of oscillation, the amplitude of oscillation will increase; a force equal in amount, but impressed at a different frequency, will decrease the amplitude of oscillation. We have here the principle of resonance in a nutshell. Extending the idea to wave motion; if a certain note be sung in proximity to a piano, the corresponding note of the piano will vibrate, and be heard in resonance with the voice. The energy in the medium—the air in the case of sound waves—alternating between potential and kinetic kind, and impinging upon the piano string, imparts energy to this mechanical vibrating system at the natural period of vibration of the string, and thereby vibration of the string is not only started but maintained. It will therefore be seen that the alternations of energy in the structure of the medium, in which manner we have defined waves, is capable of imparting energy to a mechanical system whose resilience and inertia give it the same natural frequency as the frequency of the impinging alternations of energy, and causing that mechanical system to oscillate at the same frequency. In the same manner electrical alternations are produced in an electrical system when corresponding alternations of energy are impressed upon the system by the medium surrounding it. The transmitting arrangements, as has been already pointed out, consist of an electrical system of capacity, inductance and resistance, in which oscillations are generated by an impressed electromotive force, resulting in corresponding alternations of energy in the surrounding medium. In one instance met with in practice, most of the inductance is contained in one winding—the primary—of a transformer, known as an oscillation transformer; contiguous to this winding is the secondary of the transformer, to one end of which is connected the aërial, and to the other the earth. This secondary system, consisting of secondary winding, aërial and earth connection, has certain inductance and capacity, and therefore a certain natural period of electrical oscillation. If, then, we so arrange these values of capacity and inductance that the secondary system has the same natural frequency as the primary, we shall establish by means of the energy transmitted in the intervening medium, electrical oscillations in the secondary system; and from the aërial energy will be radiated into the ether in the manner which has been illustrated. This brings us to the reception of thè oscillations, or the receiving-end arrangements. If we arrange our receiving aërial upon which the waves impinge by inserting suitable capacity or inductance, or both, so as to make the natural frequency of this system equal to that of the impinging waves, the receiving aërial will oscillate electrically in resonance with these waves. It therefore only needs a detecting device to be inserted in the system for radio-telegraphic communication to be established. This is one method of arranging the receiving station. In another arrangement the oscillating circuit is arranged as as hunt, or equivalent arrangement upon the aërial. For an illustration of this method we turn again to a mechanical analogy. Consider our mechanical system of spring and weight, instead of being fixed by its upper end to a rigid support, to be inverted, and to rest upon a table, and the table to be struck by a succession of blows at a frequency equal to the natural frequency of the mechanical system, the system will oscillate in resonance with the blows, and gather amplitude of oscillation with each successive blow. The table as a whole will not oscillate. We have an illustration of the same resonant principle in proximity to machinery which is not perfectly balanced. Although a house in the neighbourhood does not move as a whole, the smaller articles of furniture, if free to vibrate, and whose natural frequencies approach that of the alternations of force impressed by the unbalanced machine, will vibrate in resonance. The receiving aërial is analogous to the table upon which the blows are struck; in the case of the table the blows are of the mechancal order, with the aërial they are of the electrical order, electrical blows struck by the alternations of the kind of energy in the ether as the waves impinge upon the arëial. Our electrical system, containing capacity and inductance placed as a shunt across some part of the aërial, is analogous to the mechanical system of our inverted spring and weight. If the capacity and inductance of this system are so related that the natural electrical frequency of the system is equal to the frequency of the electrical blows struck upon the aërial, the system will oscillate electrically; in other words, we shall have produced in this system electrical oscillations of the same kind—but, of course, of smaller amplitude—as those generated in the transmitting apparatus. The manner of the detection of these oscillations by means of magnetic, electrolytic, and other detectors, is no doubt familiar to all my readers; their description is outside the scope of the present article.

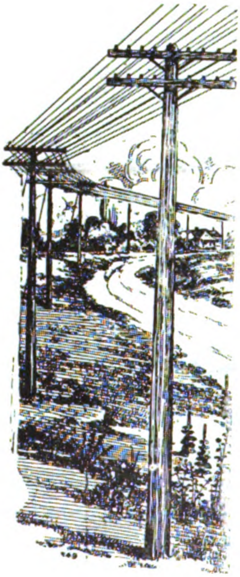
It may be of advantage, in conclusion, to summarise the processes involved in radio-telegraphy.

At the sending station electrical oscillations are generated by means of an electrical system of certain capacity and inductance; the frequency of the oscillations will depend upon the value of these factors. Energy, alternating in kind between potential and kinetic, in the form of waves, is radiated into the ether from an electrical appliance known as the aërial linked to the system. These alternations of energy deliver a succession of electrical blows to a similar electrical appliance in the path of the waves; an electrical system of capacity and inductance is attached to this appliance having the same electrical frequency as that of the originating system. Electrical oscillations are thus generated, transmitted across space, and reproduced at a distance. A form of apparatus known as a detector, in which the electric oscillations produce certain magnetic, chemical, or heating effects, is all that is then required to effect communication between two points without the intervention of a material conductor.



TELEGRAPH CONSTRUCTION ON THE CANADIAN-PACIFIC RAILWAY.

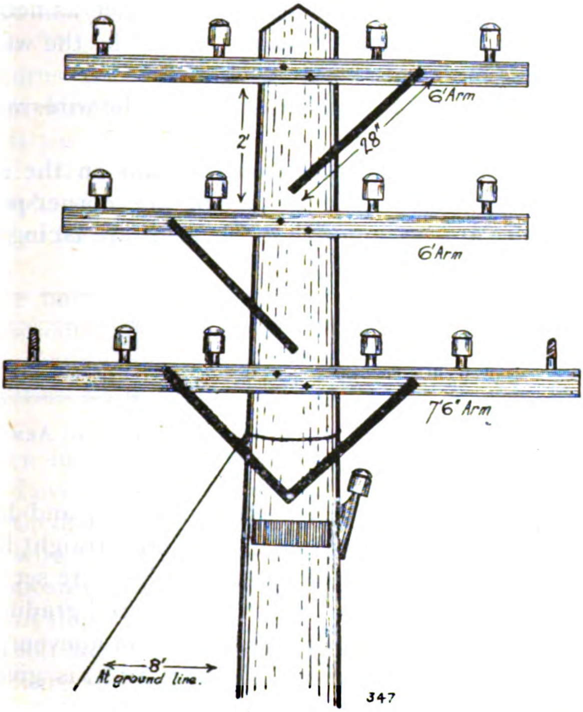
By E. A. Lakey,
Morfa Nevin.



I HAD the good fortune to be sent out to Calgary (Alberta) in connection with the opening of the Pacific Cable Board's land line from Montreal to Vancouver. Calgary is 2252 miles from Montreal on the Canadian-Pacific Railway, and naturally the Canadian-Pacific Railway telegraph construction came under my observation. As there is a general departure from our Post Office methods a short description may prove of interest.

The line of poles is located, wherever possible, at least 30 ft. from the rail, and the poles are erected from forty to forty-four poles to the mile. Two kinds of cedar poles are used, but they are not "preserved" in any way. In the Eastern Provinces the swamp cedar is utilised. These poles are rather short and crooked, and have an average life of about twenty-five years. In the West the poles are of mountain cedar. These are long and straight, and good poles can be obtained up to 120 ft. or so in length. The mountain cedar pole, however, does not last so well, and has a life of about ten years on the sandy soil of the prairie. A peculiarity of their decay on the prairie is that the rot takes place from the butt of the pole upwards, and not at the ground line, owing to the action of the alkali in the ground.

Cross-arms are of fir, and they are somewhat large in comparison with our Post Office arms. An arm for four wires, or a 4-pin arm, as it is termed in Canada, is 6 ft. long, and the 6-pin arm is 7½ ft. The top of each arm is 4 in. below the bottom of the roof of the pole, and they are fixed on the pole 2 ft. between centres, being fastened by two 6½ in. coach-screws. All 4-pin arms are braced with one iron brace, 28 in. × 1 in. × ¼ in., placed at an angle of 45°. The 6-pin arms have two braces, one on each side of the pole, and one coach-screw is used to fasten both braces to the pole. Braces are attached on the face of the pole and the face of the arm. Insulator pins are of oak and 9 in. long. The portion in the arm is 4 in. long and it is fastened by a nail.



I.—Canadian Pacific Railway. A Pole and its Fittings.

The insulators are mostly glass, and they are of all shades of blue and green. I noticed some porcelain insulators.

I gives a typical case of a pole and fittings.

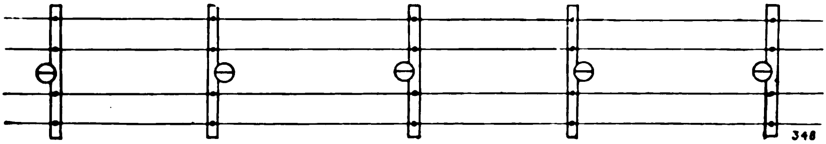
All cross-arms are fully equipped with pins when put up, and it will be seen that the two spare positions in **I** are thus fitted.

The top of a pole is made wedge-shaped, but no galvanized iron roof is fixed. Four inches of the pole are used for this purpose, so that the top of the first arm is eight inches from the apex of the pole. One or more extra slots or "gains" are cut on each pole in all new work, and where a side block or bracket line is built a flat surface is blazed on the pole at right angles to the gain, the bracket then being fastened to the pole with its top nail exactly opposite the top line of the gain. This allows an arm to be added without interfering with the bracket or the wire on it.

It is the practice to double-arm poles at each half mile to save the wires from running back in case of a breakdown. Double arms are also fixed on corner-poles and on the poles adjacent. It is also specified that the first pole from a corner must not be set to exceed 100 ft. from the corner-pole, and as much closer as necessity may require; which in all cases is to be determined by the weight of the line, and the side strain of the corner-pole.

Corner-poles are also to be located so that the wires will not turn at an angle of less than 157½°.

Poles are set up in such a way that the arms on the second pole on each side of a corner-pole are facing the corner-pole. In all other places poles are set up so that the arms are facing alternately



2.—Canadian Pacific Railway. Plan of Line, showing Arms placed on Alternate Sides of Poles.

(see **2**). Stays are used in preference to struts, and longitudinal stays are fixed on every fifteenth pole in a long, straight line.

At most of the curves I noticed that the poles were set with a very decided slant against the curve, but this was well graduated. The heights of the poles are also well graduated in uneven ground and at railway crossings. A clearance of about 12 ft. is given on high ground, and about 30 ft. is given at railway crossings.

Only every fifteenth pole is supposed to be earth wired by means of Nos. 8 or 9 galvanized iron wire for protective purposes. The earth wire extends from 3 in. above the top of the pole to within 1 ft. of the butt, where four spiral turns are made round the pole, and it is then continued to the bottom, where a coil of about 4 ft. is fastened. All terminal poles are equipped in this way.

Holes are generally dug round and 6 in. or so more in diameter than the pole to be erected. The tool in general use for this purpose is a digging bar of octagonal steel 1⅛ in. by 9 ft. Shovels and spoons for removing the soil have handles 9 ft. long. The butt of a pole is well keyed with stones, and great care is exercised in punning. Stones are heaped around the poles fixed on the prairie to prevent grass from growing, so that a prairie fire just sweeps past without damaging the line.

For erecting poles in quick-sand a special caisson is used. This is made of ⅛ in. sheet iron, 3 ft. 6 in. long, and having a diameter of 1 ft. 6 in. It is hinged on one side with a bolt on the other side so that the caisson can be withdrawn when the pole is in position.

Mostly galvanised iron wire has been strung, but some of the latest wires are 210 lb. copper, and there is between Montreal and Vancouver, a distance of 2898 miles, one of 300 lb. copper.

Iron wire is bound in by means of No. 8 galvanised iron wire 14 in. long. This is placed around the insulator and each end is given four turns around the line wire. Copper wire is bound with a soft copper binder of the same gauge as the wire being strung. The binder is placed in the groove of the insulator and crossed on the line side. The line wire is then placed over this cross and the binding completed by giving four or more complete spiral turns using up each end of the binder. Sleeves are in general use for jointing copper wire.

Wires are bound in on the side of the insulators nearest the pole except at curves where it may be necessary to place the wire on the opposite side, so that the strain is against the insulator. The general practice for leading-in is by overhead cable from a pole test-box.

To reduce inductive disturbance the Pacific Cable Board's line is transposed every half mile between three poles. I noticed three different methods of doing this:

(1) The wire was strung on the outer position of the third arm, and in transposing was raised to an additional insulator fixed on the second arm of the centre pole.

(2) A J-bolt was fixed under the second arm of the centre pole to carry the wire and insulator.

(3) The wire was strung on brackets, and at the centre pole took the outer position on the third arm.

After this brief *resumé* I will just mention the result of an insulation test I took from Calgary to Fort William on this line, a distance of 1257 miles. On a differential galvanometer, the only means of testing available, and with 200 volts, there was absolutely no loss discernible. This test was taken in fine weather.

PRACTICAL HINTS ON THE ERECTION OF LEAD-COVERED AËRIAL CABLES.

By E. Ogden,
Engineer, Oldham.

Owing to the rapid development and growth of the trunk service, due in a considerable measure to the fulfilment of the requirements demanded by the inauguration of the "*Zone* System," the main trunk routes radiating from large towns have become congested, and in order to increase their capacity, and because of the difficulties, way-leave and otherwise, of building new lines, aërial cables are becoming a frequent necessity. These cables are being used to relieve comparatively short, congested routes by taking up short trunks or telegraph circuits, which, thus removed, allow the positions vacated to be utilised for more important trunk circuits. As the official instructions and other literature on the subject are somewhat meagre on the practice of the erection of aërial cables, a few hints may be welcome to those to whom the work is entirely new, and may be of some assistance to those who may require the details of practical methods of carrying out the work.

As already stated, it is thought that the Department will employ aërial cables on routes which are regarded as full as far as open wires are concerned, and, therefore, the ideal straight line of short spans of even length, which may be to some extent possible if the poles be erected specially for the purpose, will not be considered in these notes. Unfortunately this important factor is already decided by the existence of the line, and its objectionable features have to be taken as they stand. The line will, however, in all probability lend itself to some improvements, and these should be carefully taken in hand before the suspending wires are erected.

The spans should, as nearly as possible, be equalised, and line stays erected to pull against the longer spans which are unavoidable; stays should also be fixed at the terminal poles or the existing stays strengthened if necessary. Angles should be well stayed or strutted. The points of attachment of the stay or strut to the pole should be carefully arranged, due consideration being given to the positions of the suspending wires and cables—there may be more than one in course of time—when erected, and proper clearance given so that there will be no friction between the stays or struts and suspending wires or cables. The point of attachment, with regard to resultant points, should also receive due consideration.

The timber should be examined and weak poles renewed, as the weight to be carried is being greatly increased.

The position of the suspending wires should be arranged low enough to allow of full advantage being taken of the route as far as open wires are concerned, but high enough to ensure good clearance over all obstructions, buildings, cranes, etc., bearing in mind the extra dip which will exist after the erection of the cable, amounting probably to as much as 4 to 5 ft., and possibly more in very long spans.

The suspending wires used by the Department are usually either bimetallic 400 lb. or steel No. 8, the former being used in localities having a chemically charged atmosphere, and the latter in country districts and localities where the air is purer. Other types of wire are sometimes used, and full particulars with useful detailed information with regard to these are to be found in Mr. Wakefield's remarkably useful notes on "The Construction of Aërial Lines," read before the Metropolitan Centre of the I.P.O.E.E. on December 9th, 1907, and since printed.

The number of suspending wires varies with the length of span and the weight of the cable per foot, and each individual case is, as yet, decided by the Engineer-in-Chief.

In the case of an aërial lead-covered cable recently erected at Ashton-under-Lyne, the following particulars will be of interest:

Type of cable: Cable P.C. aërial twin $\frac{14}{40}$.
Diameter, ·560 inch; weight per foot ·528 lbs.
Type of suspending wire: bimetallic 400 lb.

Number of suspending wires.	Length of span.
2	up to 66 yards.
3	66 to 93 ,,
4	93 to 110 ,,
5	110 to 130 ,,

The suspending wire is wrapped twice round the pole, and terminated in the same manner as an ordinary line wire. If erected between arms it should be fixed close under the arms, so that when the cable is erected it will hang clear of the arm below, and damage to the sheath by vibration or friction will be avoided.

Mr. Wakefield recommends that sheet zinc be wrapped round the poles to prevent the suspending wires cutting into the timber, but it is doubtful whether the benefit derived is not more than counterbalanced by the chemical action which will take place in damp weather between the copper deposit on the bimetallic wire and the zinc and the ill-effect consequent thereon.

In the case of round poles the cutting mentioned has not been found to be appreciable. No doubt there are engineers who could give interesting information on both points, which would be welcomed.

The suspending wires should be erected as close together as possible and bound near the pole, otherwise the suspenders are forced open.

The tension to which the wires should be erected varies with the circumstances, length of span, and weight of cable, but care should be taken that a factor of safety of at least 4 is allowed.

In the case of a cable erected at Ashton-under-Lyne the spans varied from 50 to 80 yards, and the two suspending wires used were each pulled up to tension of 400 to 600 lb. at a temperature of 34° F., the dip varying from 3 in. to 9 in. approximately. When the cable was erected the dip varied from 1 ft. 6 in. to 3 ft. 6 in.

The suspending wire should be supplied as far as possible in one length. Joints in the spans are extremely objectionable, as they prevent the sliding of the suspender hooks along the wires during the drawing out of the cable and slow down the work considerably.

If joints become inevitable owing to the supply of the wire in pieces, and lack of time prevents a further supply, the jointed pieces should be erected in the last span for preference, but must be erected in a span which can be reached by ladders, as it will be necessary to ease the hook over the joint by hand or by the use of rods.

The question of the best method of drawing out the cable is not one to be settled off-hand, but the writer is of opinion that if a winch is easily obtainable, or the cable is of sufficient length to justify the cost of transport, its use will be more satisfactory than hand-drawing, both on account of the steadiness of tension and its comparative cheapness. Where the line is tortuous extreme care is necessary, and rollers should be used at angles to reduce the strain and avoid friction. These rollers can be improvised by adapting the large ratchet drums, otherwise much time is lost by the necessary easing by the men up the poles.

Where hand-drawing is employed the number of men, commencing with two, will gradually need increasing to five or six as the length of cable drawn out increases, up to about 400 to 500 yds. which is about as long a section as would be erected at one drawing with safety.

In the case of the Ashton cable the experiment was tried successfully of erecting the cable in one length, starting from a centre and pulling out both ways. The cable thus erected was 725 yds. in one length, it being considered that this method was preferable to the introduction of a weak point by the jointing of the cable which would otherwise have been necessary.

It will perhaps be interesting to describe the method adopted.

The drum, containing the whole of the cable, was mounted at a point a little more than halfway from one end of the line, and the longest side erected from the drum. When this length had all been erected the remainder on the drum was unwound and coiled on tarpaulins on the ground, in the form of an oval of large area. The shorter length was then erected in the same manner as the longer length, but from the coil. The adoption of this method entails the exercise of great care to prevent kinking, or damage to the cable sheath.

The number of men required varies in accordance with the length of the cable to be erected, and with the progress of the work. This will be evident when it is remembered that two men should be up each pole, one to take off the suspender as it arrives, and the other to transfer it to the suspending wire on the other side of the pole. The number of poles to be so manned of course increases as the cable is erected.

Three men should be told off to feed the cable—one to steady the drum, one to fix suspenders, and the other to mark the cable once every yard to indicate the final positions of the suspenders. The writer found the best method of marking to be the finger and thumb, smeared with black varnish, run round the cable, the marking being plain and the varnish too thin to spread by rubbing or contact and thereby preventing false marks. A yard-stick can be easily improvised.

When the cable is being run out the suspenders should only be fixed 3 or 4 yards apart, but not less frequent, or a danger of damaging the sheath of the cable by kinking is introduced. This method should be maintained until a distance from the terminal point is reached which is equal to the longest span on the line; all the men should then commence to fix suspenders one yard apart, so that when the cable reaches the terminal point it is complete with suspenders in every span.

It is extremely important to remember that the cable should always be erected on the inside of the angle of the poles, so that when the cable is finally pulled up it will hang out from, and clear of, the timber. Extra suspenders should be fixed where possible on poles or arms to ensure this and strengthen its support.

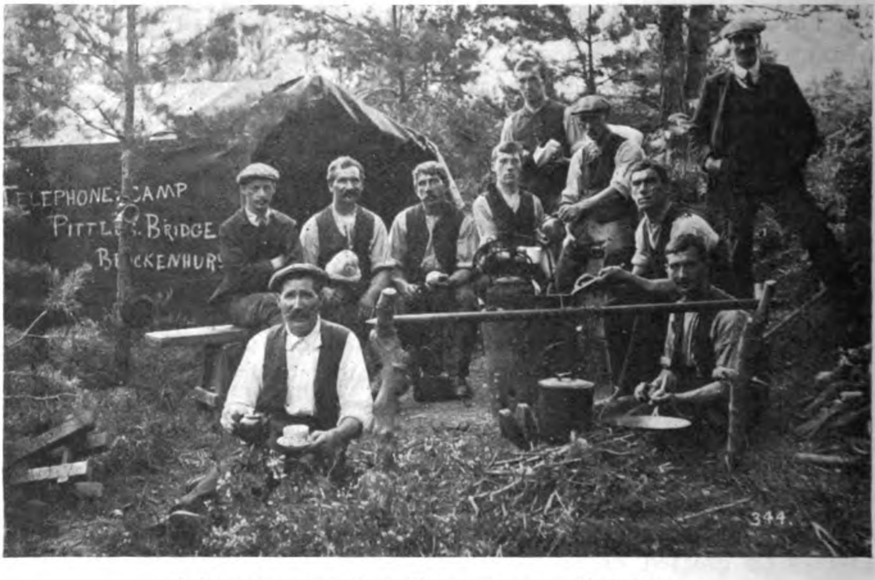
It will be obvious that joints are a source of weakness in all cables; in aërial lead cables they are especially so, as they are subject to vibration and need special support. The chances of weakness are increased also by the awkward position of the jointer when making joints up the poles, as jointing operations carried out on a temporary platform fixed on the arms, or by bo'sun's chair, cannot be expected to be of ideal perfection.

At the terminal point the permanent position of the joint may be such that the joint can be made on the ground; but if not, the cable should be drawn back and sufficient length obtained, and re-erected after jointing.

The cost of the erection of aërial lead-covered cables must vary according to circumstances, but it is thought that the average cost for the whole of the work, including jointing, should not exceed 4*d.* per yard along pole lines which are not overhouse routes.

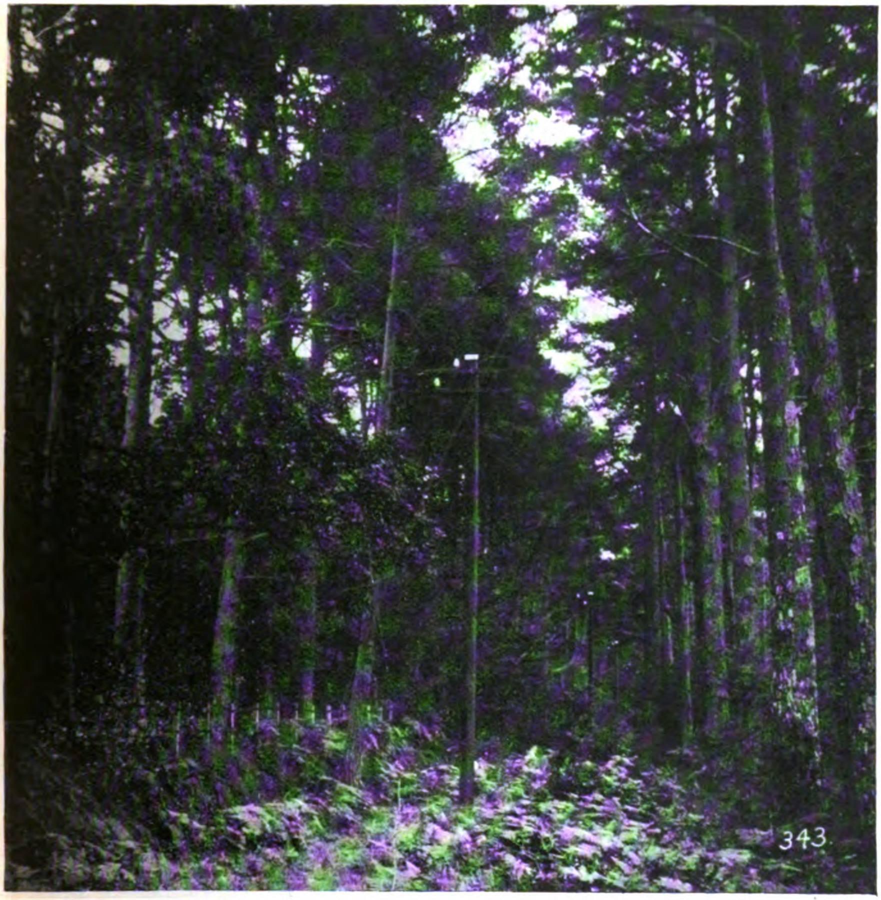
TELEPHONES IN THE NEW FOREST.

PERMISSION to camp in the New Forest is sought by many, but not readily obtained, and the Post Office working party shown in the photograph was fortunate indeed not only in being allowed to camp, but in having good weather and the best period of the year in which to carry out the work of building the trunk line connecting the villages of Lyndhurst and Brockenhurst. The camp was pitched on a site selected by the Forest Authorities in an old sand quarry near the river Ober, which afforded a supply of pure water for both washing and drinking purposes. The postal address can be seen on the tent. Sleeping accommodation was obtained by extending the 12 ft. by 6 ft. shelter-tent by means of fir posts and branches to 18 ft., and covering the extension with a tarpaulin. Food was obtained from the village of Brockenhurst, which is some three miles from the camp, but where it is very difficult to obtain lodgings in the



A CONSTRUCTION GANG CAMPING IN THE NEW FOREST.

summer and autumn, owing to the influx of visitors. The second photograph shows a portion of the line erected through one of the pine plantations where the Forest Authorities do not object to tree-cutting, the timber being of little value except for pit props. The only drawback from a maintenance point of view is that the lineman in charge of the length must ot necessity go to the expense of always keeping well shod as these forest glades are usually damp. Near the section shown the bracken often attains the height of 8 ft., and care must be taken in choosing the way as it is a very easy matter to get lost.



In the Depths of the Forest.—A Line of Tame Pine Telephone Poles surrounded by their Untamed Brethren.

J. S. B.

THE DECAY AND PRESERVATION OF TIMBER.

By W. H. Matthews, B.Sc.

Introductory Note.—It is probably true that this subject is of greater interest to the builder, the architect or the timber merchant than to the telegraph and telephone engineer. The great bulk of the timber used in our service is in the shape of poles and cross-arms, the preservative treatment of which has long been standardised and is mostly in the hands of contractors. It is rarely, therefore, that we are faced by emergencies calling for an intimate knowledge of the mechanism of decay, and moreover the methods adopted for the conservation of our timber have proved so efficient that it may be long before we shall require any notable alteration in them.

At the same time it cannot be denied that our poles do eventually decay—some of them prematurely—and cases do sometimes arise involving the use of ordinary structural timber; besides, we have in use hundreds of ladders, hand-carts, silence cabinets and so forth, in all of which uncreosoted timber is used. The high grade of efficiency of our present preservative process does not entirely preclude the possibility of advance in this direction; finality has not yet been reached, either in our knowledge of the agents of decay, or in our ingenuity in defeating them.

Chemists, botanists, engineers, and forestry experts continue to put forth contributions on the subject, and governments annually expend a considerable amount of money in furthering such investigations.

Unfortunately the literature is very much scattered, and it is difficult to find any concise and up-to-date, yet elementary, epitome of the whole matter.

A practical paper on "The Inspection of Wrought Timber" was read by Mr. F. L. Henley before the Metropolitan Centre of the Institution of Post Office Electrical Engineers in November, 1908, and a very interesting illustrated article by Mr. A. O. Gibbon on "The Telegraph Pole" appeared in the Oct., 1910, issue of this journal. The paper lately read by Mr. Henley at the Paris Conference, "Some Recent Tests of Creosoted Wood Poles,"* contains some valuable information and is also illustrated by photographs, to some of which I shall, later on, take the liberty to refer. Nevertheless, the subject of the decay of timber, its causes and prevention, has not hitherto been treated of, so far as I am aware, by any of our members.

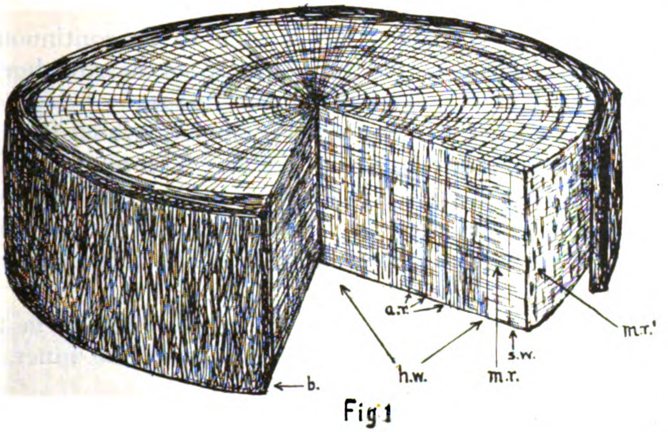
On the whole, then, the following brief outline of the nature of the problem, and of its present state, may not be out of place.

---

* References to other literature will be given in tabular form at the conclusion of this article.

TIMBER: STRUCTURE AND COMPOSITION.—Each of the common timber-yielding trees belongs to one or the other of two great divisions of flowering plants, the Conifers or the Dicotyledons. The first-named group includes all the pines, firs, spruces, larches and allied plants; the latter, which is by far the larger group, includes the oak, beech, elm, mahogany, chestnut, and many others, most of which are easily distinguishable from conifers externally by the possession of flat broad leaves instead of "needle" leaves.

It is not always possible to say at a glance to which of these two classes a given piece of worked timber belongs, but a microscopical examination of a fragment reveals certain distinctive features which will be mentioned below. Often, however, the conifers may be recognised by their sharply marked "annual rings" and by the resin which many of them contain.



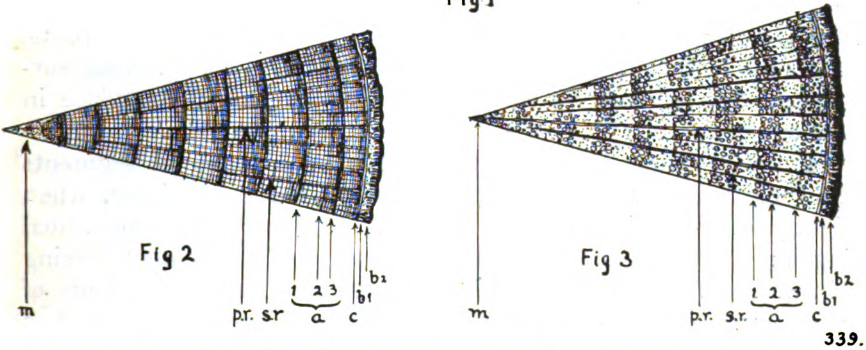


FIG. 1.—Segment of log of timber, showing: *h.w.*, heartwood; *s.w.*, sapwood; *a.r.*, annual rings; *m.r.*, medullary ray; *m.r.*[1], outer end of ditto; *b.*, bark.

FIGS. 2 and 3.—Diagrams of typical conifer and dicotyledon respectively. *b1*, inner bark; *b2*, outer bark; *c*, cambium; *p.r.*, primary ray; *s.r.*, secondary ray; *a*, annual ring; *1–2*, spring wood; *2–3*, autumn wood; *m*, remains of pith.

In **1** is shown a segment of a log which might belong to either group. It is arranged so as to show the features common to most timbers. On the outside is a thick layer, or series of layers, commonly spoken of as the "bark," whose structure, though complex, does not concern us here.

Inside this is seen the solid woody cylinder, at the centre of which are the crushed-up remains of what was, in the early stages, the pith. The wood is obviously not homogeneous; it is seen to be composed of concentric layers of different consistencies, forming what are called the *annual rings*, whilst across these are lines of finer tissue radiating to the circumference—the *medullary rays* (from *medulla*=pith).

In the radial section each ring is seen to be continuous in a vertical direction, whereas the rays appear as narrow horizontal bands of various depths, not vertically continuous.

The rings are the edges of concentric cylinders, whilst the rays are like spokes irregularly arranged on a hub. The outer ends of the rays can be seen on the surface of the wood where the bark has been removed. Some of the rays penetrate to the centre, but most of them cease at varying distances from it. The former are called *primary*, the latter *secondary* rays.

The wood near the surface is seen to be rather lighter in texture than that further in. It is termed the *sap wood*, the inner, denser portion being the *heart wood*.

The chief distinction between them is that, in the living state, the sap, *i.e.* the water with dissolved salts sent up from the roots, passes up by means of the sap wood, the heart wood having surrendered this function owing to changes which have taken place in its elements.

2 and 3 show diagrammatically the appearance of segments of a typical conifer and of a typical dicotyledon respectively, when slightly magnified in transverse section. In the first case the annual rings are seen to be due to the alternation of bands of elements having thin walls and large areas with bands of thick-walled elements of small cross-section—nearly all the elements being more or less rectangular in section.

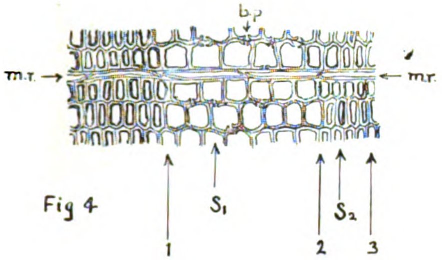
In the second case the bands are alternately composed of small elements and of these mixed with large elements of circular cross-section.

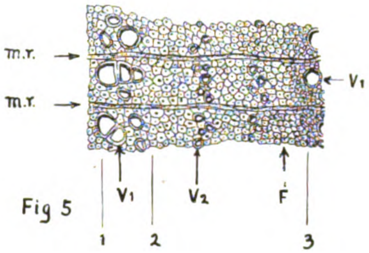
4 and 5 represent small portions of these sections more highly magnified.

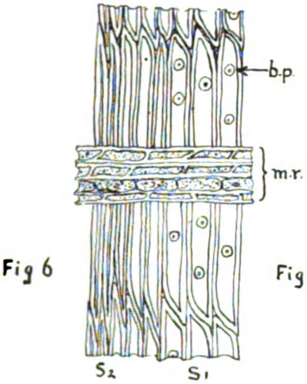
Between the bark and the wood is a very thin layer of delicate cells, by the disruption of which one is able to tear the bark from the tree.

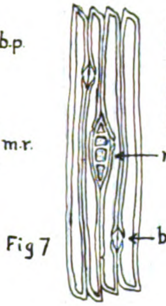
This layer is called the *cambium*, and is very important in the living tree because all the other parts of the trunk are formed from it. Each of its cells divides in a tangential plane, one of the resulting cells remaining a cambium cell, the other becoming transformed into an element of the wood or of the *bast* (inner bark) according to whether it is formed on the inner or the outer side of the cambium. It is thus that the tree grows in thickness. Most of the cells are formed on the inner side of the cambium and go to form additional wood elements, but they do not all form elements of the same pattern. Some of them become cells of medullary rays, the others grow into fibrous, tubular or prismatic cells, with their long axes parallel to that of the tree.

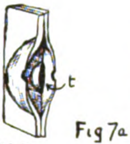
In the spring, when the sap is rising, the elements formed are relatively thin-walled and of large cross-section; in the summer and autumn they have thicker walls and small cross-section. Hence the annual rings.











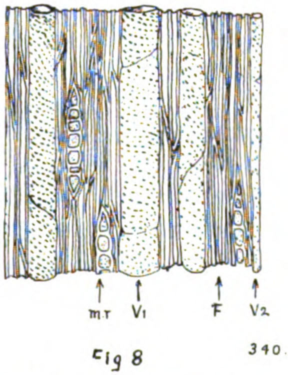


FIG. 4.—Portion of Fig. 2 highly magnified. S_1, tracheids of large cross-section, some of them with bordered pits, *b.p.*, in their walls; S_2, tracheids of small cross-section, with thick walls; *1* to *2*, spring wood; *2* to *3*, autumn wood; *m.r.*, medullary ray.

FIG. 5.—Portion of Fig. 3 highly magnified. V_1, large vessels; V_2, smaller vessels; *F*, fibres and tracheids; other lettering as above.

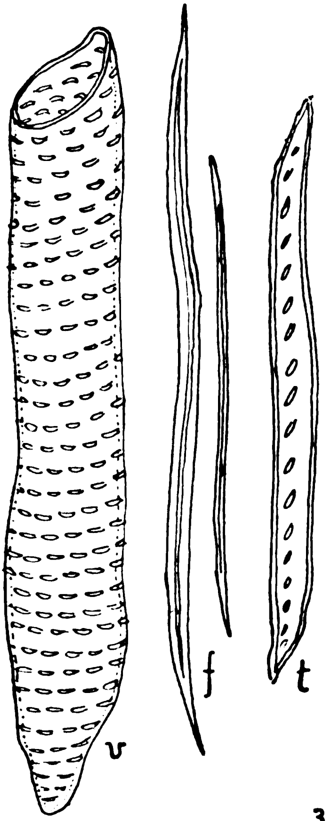
FIG. 6.—Portion of Fig. 4 in radial section, the plane of section passing through the medullary ray. Lettering as above.

FIG. 7.—Portion of ditto in tangential section, *i.e.* at right angles to Fig. 6.

FIG. 7*a*.—Sketch to show structure of a bordered pit.

FIG. 8.—Portion of Fig. 5 in tangential section, rather more highly magnified. Lettering as in Fig. 5.

In the diagrams (2–5) an annual ring is indicated between *1* and *3*. From *1* to *2* represents the spring wood and from *2* to *3* the summer or autumn wood. In 4 and 5 are shown transverse sections of small portions of wood from a typical conifer (pine) and dicotyledon (elm) respectively, and in **6**, **7** and **8** corresponding longitudinal sections. Such sections may easily be obtained by shaving off minute portions of wood as thin as possible with a razor, and may be observed by placing them in a drop of dilute glycerine on a glass slip under the microscope. It will be noticed that wood from a dicotyledon differs from that of a conifer principally in the possession of *vessels*, which are composed of large elements whose end-walls have disappeared, and which are placed end to end, thus forming tubes which extend the length of the trunk and serve for the conveyance of sap.



341.

Fig. 9.—Elements of the wood separated out (from an oak), very highly magnified. *v*, cell forming part of a vessel; *f*, fibres; *t*, tracheid.

After some years these vessels often become blocked up by ingrowths from surrounding cells—a fact which helps to explain why heart-wood does not conduct water.

The chief types of elements composing dicotyledonous wood are shown separated in **9**. The *fibres* are the elements which contribute most to the elasticity of the timber. The *tracheids* are elements somewhat resembling the vessels, but having their cross-walls intact; their ends are usually chisel-shaped. It will be noticed that all of these larger elements have peculiar markings on their walls. These are very thin places in the walls, called *pits*, through which transfusion of fluids can take place. In the tracheids of conifers we find a rather elaborate type of pit called the "bordered" pit. Some of these are seen in external view in **6** and in section in **7**, whilst **7A** shows a very highly enlarged view of one of them cut across to show the internal structure. The cell-wall bulges out on each side to form little domes, pierced at their summits and separated by an extremely thin membrane, which is thickened about its centre so as to form a little pad which can rest against and thus close either opening. This arrangement is an ingenious device to regulate the rate of transfusion of sap between adjacent tracheids.

The bordered pits are so characteristic that they render coniferous wood easy of detection by the aid of a microscope.

In amongst the wood elements of many conifers are found longitudinal spaces or canals filled with resin, which oozes into them from the cells surrounding them (secretory cells).

By the time the wood elements pass into the heart-wood stage their protoplasm, *i. e.* the jelly-like substance of complicated chemical structure, which is the physical basis of all life, and is the essential component of every living cell, whether of plant or animal, has entirely disappeared, so that the heart-wood is, in fact, dead matter, and is incapable of further growth. In the sap wood, on the other hand, the protoplasm (or "albumen," as it is sometimes called), still remains lining the inside of the wall of each cell, and it is one of the main objects of the various seasoning treatments to coagulate or to decompose and remove this substance, which is highly nutritive to the organisms which cause decay, affording them a foothold whence they can attack the more resistant components of the wood.

CHEMICAL CONSTITUTION.—It would be inappropriate in the present paper to digress far into the wealth of research that has been carried out on the chemistry of plant cells, but the action of the decay organisms on the wood material cannot be properly grasped without a slight reference to the chemical composition of the latter. The chemistry of wood resolves itself at once into the chemistry of its constituent cells and their contents.

In the young stage each cell consists of a little mass of protoplasm enclosing a drop or drops of cell-sap and covered all round by a thin, firm coat, the cell-wall. Protoplasm is a compound of the elements carbon, hydrogen, oxygen, nitrogen, and sulphur, with a trace of phosphorus; it has a very complex molecule and is classed by chemists in the proteids. It possesses the property of coagulating on being heated (*cf.* the "white" of an egg). It builds up the wall around itself as a covering, using for the purpose the materials supplied in the sap (after the latter has been treated in the cells of the leaves), and it gives forth the ingredients of the wall in a certain order.

On testing the wall of a young cell we find it to be composed chiefly of *cellulose*, a carbohydrate having a chemical formula like that of starch ($C_6H_{10}O_5$). Somewhat similar compounds named *pectoses* are also present. Under the higher powers of the microscope it is found that the surfaces of contact of adjacent cells are coated with an extremely thin layer of a substance which evidently acts as a kind of cement, and, from its chemical reactions, is thought to be *calcium pectate.* It is apparent that if this layer be dissolved the cohesion of the cells is lost, and we shall presently see that this is the way in which disintegration of wood is sometimes brought about.

As wood-cells mature the walls become thicker by further deposition, and presently their chemical composition is altered by the addition of a substance which combines with the cellulose and forms a compound known as *lignose*, which, as its name implies, imparts the essentially *woody* character to the cells. The cell-walls are then said to be *lignified* and can be readily distinguished from non-lignified cells under the microscope by successively immersing them for a few seconds in solutions of the dyes *safranin* and *hæmatoxylin* (logwood), when the lignified cells will be stained red by the former and the non-lignified cells blue by the latter.

The exact composition of lignose is still a matter of dispute, but, at any rate, we may regard it as a compound of cellulose with another substance (hadromal). Now if we found an agent which would split up this compound again we should be able to destroy the hardness of the cell-walls and reduce them to the non-lignified condition, which is precisely the course followed by certain organisms to be presently considered.

There are known to chemists a large number of peculiar compounds named *ferments* or *enzymes* that behave as *catalytic agents*, that is, they possess the power of setting up, or at any rate accelerating, chemical changes in certain other substances without being themselves affected. Such, for instance, is the ferment that exists in brewers' yeast, and has been discovered to be capable of carrying on the process of fermentation without the presence of the microscopic yeast-cells which produced it.

That particular enzyme confines its operations to the splitting up of sugar molecules, but others act similarly upon molecules of starch, of cellulose, of pectose, and of lignose.

Bearing this in mind, we are now ready to consider the manner in which wood is caused to decay.

(*To be continued.*)

A SIMPLE RECTIFIER.

By Geo. Sutton.

The battle waged between the direct and alternating current systems for general power and lighting purposes has now been almost won by the latter, and although the Post Office engineer is compelled to be at variance with the rest of the world in taking sides, as much for reasons of accumulator charging as upon the ground of telephonic induction, he has perforce to bow to the verdict of the majority and accept circumstances over which he has no control.

It does not fall within the scope of this short article even to sum up the arguments *pro* and *con*, but the writer, sitting at the feet of that apostle of alternating and polyphase currents, Prof. Silvanus Thompson, in 1896–8, was so impressed with a sense of the inevitability of the advent of the triumph of pulsating electromotive forces that he had no doubt as to which side would win.

To the average electrical man the consideration of the alternating circuit is a horrid nightmare, to be avoided if at all possible, and the subject may be fairly represented as the electrical engineer's Straits of Scylla, where the voyager is in imminent peril of being wrecked upon the rock of stony indifference, or swept into the boiling whirlpool of the higher mathematical treatment of the subject, and thenceforward only talk in terms of magnetic viscosity and hyperbolic trigonometry.

Early in 1900 a friend of the writer came to him in trouble. The current had been laid on to his house and he desired to use it in his practice as a doctor for X-ray and other electro-therapeutical work. Unfortunately for him it was alternating 200 volts 100 cycles, and it was not until he had damaged a nice 8-in. spark coil that he fully appreciated the difficulties of adapting the conditions to his needs.

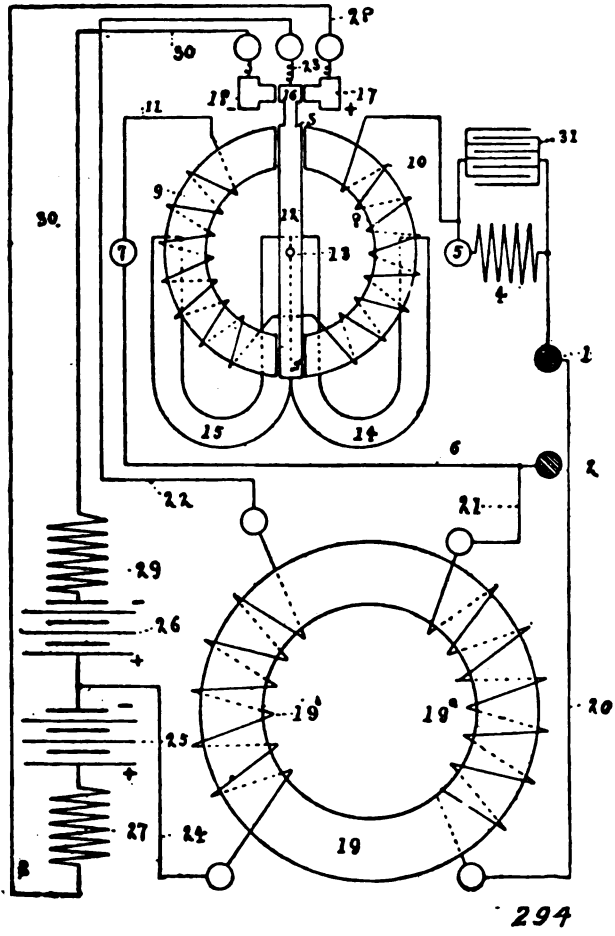
After a great deal of experiment with a Stroh relay another form of polarised relay was designed, by means of which an alternating current of 5 ampères at a fairly high voltage could be rectified without difficulty. This was not done, however, before a considerable amount of investigation as to the best form of permanent magnet and magnetic circuit had been carried out. Laminated cores were a *sine quâ non*, and ordinary horse-shoe permanent magnets were adopted for polarising, one pole-piece also forming the end plate for the vertical pivot of the armature. An iron stamping of about 3 in. square outside and a square hole of 2 in, inside was taken and cut in two, so that each half was like a block capital letter E with the middle spur removed. A soft iron stud was riveted into the assembled laminations midway along the long side, and a winding of insulated copper wire placed on each side of the stud. The other end of the stud projected through the base-plate and into contact with one pole of the horse-shoe magnet, the other pole being in contact with another stud riveted into the base-plate and lying alongside the armature pivot and terminating close to the middle of the armature. For diagrammatic purposes we may represent this laminated electro-magnet as being composed of half rings, as in fact in the earlier stages of the experiment it was. It will be seen, then, that a very close magnetic circuit was formed with four alternative paths for the flux, up from the stud over one pole of the horse-shoe magnet, round either side of the assembled stampings across the air-gap to the armature, through the soft iron studs near the pivot of the armature, back to the other pole of the horse-shoe. Similarly for the other half of the electro-magnet. A remarkably strong and prompt action was thus secured and a ready response to a small alternating current. In practice we used to drive through a 5 candle-power 200 volt carbon lamp direct from the mains. Now, as no effect can precede its cause there was mechanical lag in the armature, because the current in the limbs of the electro-magnet had to grow to some height, by reason of the alternating voltage, before the armature could be impelled over to the one side or the other. This mechanical lag was compensated for by the electrical lag between the primary and secondary windings of the transformer, and for additional phase tuning purposes a condenser was placed in shunt across the lamp. When adjusted electrically for a certain periodicity and voltage the instrument would work indefinitely without further attention. No trouble was experienced when the alternators at the central station ran out of step, although the altered note gave an immediate notice of the fact, and a microscopic spark could be detected at the contact points.

It will perhaps help to an appreciation of the application of the foregoing if we trace the course of the current with the aid of the diagram.

1 and 2 are the main alternating leads, and it will be seen that the circuit 1, 20, 19^c, 21, 2 is the primary of the transformer 19. This had a sufficiency of winding to choke back perfectly when nothing was being taken out of the secondary. The experimental

facts were: With 2 sq. in. of cross-sectional area of ring stampings (uncut) 400 turns of copper wire completely choked back an alternating pressure of 200 volts at 100 cycles.

Back to point 1 again. 4 is the 5 c.p. driving lamp shunted by the condenser 31, and the circuit is completed round the electro-magnet 10, 9, 11, 7, and back to 2. This is the driving circuit. The derived or charging circuit from the secondary of the transformer 19^b, *viâ* 22 to 23 on to the tongue of the armature 16, and according to the direction of the current, on to the stops 17 or 18. Suppose at the instant it is + in sense. Then the tongue is lying against the stop 17 and the current proceeds by way of 28, steadying resistance 27, through the battery and back to the other terminal of the secondary of the transformer. The next instant the circuit 18, 30,



I.—Scheme of Rectifier.

29, 26 gets a share. After we had gained confidence we found it possible to dispense with steadying resistances when the voltage of the secondary of the transformer was not excessive in comparison with that of the battery under charge. A transformer with various windings of the secondary tapped on to a plug-switch gave a very great range of voltages for selection, and the alternating circuit proved itself infinitely more flexible than the direct circuit could be. In addition to flexibility the very high efficiency of the device is noteworthy, being in this respect far in advance of rotary machinery with heavy frictional losses. So far as the writer's experience goes 5 ampères has been the practical limit, but with extended research doubtless much greater currents could be handled. The simplicity of the arrangement and its consequent little liability to get out of order is another point in its favour, and for reliability it may be mentioned that a firm of cycle engineers have had one running since 1903, and it is still doing good work in charging motor-cycle accumulators. As an outcome of the experiments indicated it was demonstrated that pure silver made admirable contacts for the relay, and conducted well even when completely black with oxide or sulphide.

When the relay was mounted with its base-plate vertical, and the armature horizontal, the tongue was extended by means of a light aluminium arm terminating in a bronze wire that dipped into a mercury pot and made an efficient break for a spark-coil fed directly from the alternating current. The speed, of course, could not be varied, as it was imposed by the rate of alternation, but the amplitude of vibration was considerably augmented by attaching a flat spring to the other end of the armature, and clamping it rigidly at a harmonic point. This break proved itself particularly suitable for working a Tesla coil for high-frequency oscillations.

WAYLEAVE REMINISCENCES.

By W. W. Vyle.

In writing on this subject I do not propose to go into the legal side of the matter; this has been already so well treated by those who have had the qualifications and ability necessary for the clear explanation of obscure points in the several Acts of Parliament. My object is to give some of the experiences of sectional engineers in the course of obtaining wayleaves or consents from private owners for the placing of poles and the erection of wires over their property.

Some diversion and relief from technical matters will perhaps be acceptable to the readers of this magazine, and may lead to the recounting of similar and perhaps more interesting experiences.

The cases are nearly all my own personal experiences, but a few have been told to me by engineers from time to time.

Some years ago an extension of the telegraph had to be made to a village in Lincolnshire, and when erecting the wire it was found that a very fine chestnut tree would have to be cut to allow the wire to pass freely through. Inquiries were made as to the ownership of this fine tree, and I learned that a cattle dealer living in a house in the village was the person who alone could give consent, and that he was a very hard man to deal with. I asked a friend of mine who knew this man to help me in the matter, but he firmly declined, saying that he would not dare mention the subject to the owner as he was sure he would refuse. Having failed to enlist any aid, I felt that I was bound to see the owner myself, however rough he might be or unwilling to allow the tree to be cut.

I called at the house, and was informed that the owner was not at home, but was expected in about an hour's time. I explained to the servant the purport of my call, and asked her to mention it to her master when he came in, and that I would call later on in the day. This she promised to do, and I then strolled round the village, inspected the church and churchyard, and in this way leisurely occupied the time of waiting.

I noticed the village policeman was on his beat, and that he passed me once or twice, but this did not cause me any anxiety.

After an hour or so had passed in this way I again went to the house of the owner of the chestnut tree, and on asking the servant if her master had returned I was told he had, and I was requested to go into a room opening off the hall. I entered this room but found it dark as midnight, although outside the sun was shining brightly.

A voice from some part of the room asked me to find a seat, and after groping about I fortunately found a chair and sat down. Not a word was spoken for about ten minutes. Then the voice asked: " Do you smoke? If so, light up."

I filled my pipe and struck a match, and by the light it gave I saw that two men were in the room lying on couches. Not another word was spoken in this room until I had finished smoking my pipe; this takes about twenty minutes, and I was wondering how long the silence would last and I could get out of the darkened room when the voice said, " You want to cut my chestnut tree, do you? Well, you seem a decent sort of fellow, so I will let you do so." I thanked the speaker and asked him if he preferred to do the work with his own men or would he leave it to me. The voice again told me to cut it by my own men, and if it was not done properly I should hear from him.

I again thanked the speaker and groped my way from the room, not having seen the giver of the consent.

I then went to the village post office and called on the postmaster, subsequently returning to Head-quarters.

On my next visit to this place I was told by the postmaster that I had narrowly escaped arrest on my previous visit. It appeared that the village policeman had seen me loitering about the village and churchyard, and he had, in his own view, identified me as the person wanted for a felony. He had received a circular from his head-quarters with a photograph of the person wanted, and had connected me with the case. He had secured assistance, and was about to lay hands on me first as I entered the village post office. The policeman, immediately I left the counter, asked the postmaster if he knew me, and on being told who I was found that he had lost a good case.

Other amusing cases are the following:

In a Lancashire town a pole stood in the backyard of a house; the owner came to me and asked for rent to be paid for this pole. I could not find any record showing by whose authority or consent it had been erected in the position occupied. The owner of the premises demanded fifteen shillings per annum, stating that his reason for asking this particular sum was due to the fact that at the church he attended the members were about to erect a new organ, and he wanted the fifteen shillings to devote to the fund being raised for this purpose. I pointed out to him how exorbitant and absurd his claim was, but could not induce him to alter the amount; all I could get from him was that he wanted fifteen shillings for the organ fund, and he would take nothing less. In this instance a wayleave was negotiated next door and the pole popped over the wall!

In a large northern city I had told a foreman to go to an agent, from whom he had obtained several important wayleaves at nominal rents, to obtain consent for the placing of a pole in the backyard of a house. For some reason he put the matter off for a few days, and, as I was desirous of settling it, I went to see the agent myself. He received me very courteously, but demanded five shillings per annum, and from this amount he would not move. When I returned to my office the foreman met me, and I told him the result of my interview with the agent. The man smiled, and said that he had gone to this agent a few minutes before me, and consent had been given to him for one shilling. Evidently my appearance had led the agent to raise the price!

In one of the eastern counties complaint was made to an engineer that a pole erected on the roadside near an orchard had injured an apple tree. On investigation it was found that the apple tree affected was some yards away from the pole, and that no other tree stood between it and the pole.

This was pointed out to the owner of the tree, but he persisted in saying that the pole had affected his tree, and pointing to the number 13 on the pole, said this positively proved his assertion, and demanded the removal of the pole from opposite his property.

The matter was eventually settled by placing the number 13 on pole 12 and 12 on 13, the complainant being quite satisfied that this arrangement would prevent any future mischief being done to the tree!

Sometimes the engineer has a very uncomfortable time when interviewing owners or agents of property with regard to payment for poles which have been erected by verbal consent.

After a lapse of years another owner enters into possession, and, not knowing the circumstances attending the erection, assumes that an encroachment has been made without any authority. Occasionally an engineer, after negotiating a wayleave, omits to send the usual consent form to the owner, or, having sent it, fails to see to its prompt return, and both parties forget the matter altogether; there is consequently no record to show the circumstances under which the encroachment was made.

I had a very unpleasant experience in a case of this kind, where some years ago I succeeded an engineer who was not very particular in obtaining signatures for consents which he had secured by personal interviews. I was one day informed by the foreman of a working party that he had been stopped when carrying out the renewal of a pole in a back yard, and that the owner had told him he would have him locked up for trespass, as the pole had been placed in position without his authority; also that no rent had been paid for the privilege, and he had waited for some time to see who would turn up and claim the pole.

I called upon the agent to discuss the matter with him, and for about half an hour this gentleman gave me his views on the wickedness of the Government servants and the generally mean way in which the telegraph engineer planted poles on private property. I had never previously been so painfully made aware of our boldness in regard to these matters.

I stood this for the time named, and wondered how much longer I could restrain myself from answering him in similar language; fortunately, I had the discretion to remain quiet till he had said his all. I then told him that I could not account for the absence of the usual consent form, but that I had come to settle the matter with him, and that my senior officer would expect me to do this, but if I failed he would think me a fool, and I hoped he would come to terms with me. These few words mollified the gentleman so much that we settled the matter satisfactorily. I often reflected on the painful time spent in that office, and whenever I met the gentleman subsequently the interview came back to me vividly.

Sometimes the difficulties met with are of another kind. In my early days of engineering service I accompanied an old inspector to call upon a man who owned a piece of land on which it was desired to erect a pole. The man was willing, but his wife was unwilling. Several attempts had been made to get a consent form signed, without success. On the day to which I refer the man was found alone, and the inspector promptly asked him to go to the nearest hotel! The adjournment was duly made, the inspector assuming that he would now obtain the signature he so much wanted to the form which he had ready in his pocket. Refreshments had been ordered, and the preliminary talk about the weather in progress, when the door was opened and the man's wife came into the room and sat down. She was asked to take something, but refused, and, instead, gave the inspector the full benefit of her thoughts about him and his dishonourable methods of bribing her husband! That wayleave was never completed.

Refusals of wayleave are frequent, but an engineer never knows his luck. One gentleman, on being asked if he would allow a standard to be put on his building, readily agreed, saying, "I think that a lot of wires on a building gives it a business-like appearance, and leads people to believe that the house is doing good trade."

I call to mind a large warehouse in a northern city, the elevation of which, from an engineering point of view, would give capital clearance all round, but for years no one ventured to ask permission to erect a standard. One day, however, a young engineer had the temerity to apply for the coveted position, and received immediate consent at nominal rental.

Property owners will sometimes retaliate on the Department when trouble arises and get back some of the money which they consider has been kept from them. The owner of a strip of land on one side of a brook flowing through an ancient town was asked to give wayleave for a terminal pole on his ground, he demanded so high a high a rental that consent was sought and obtained for the accommodation required on the other side of the brook on an extremely narrow bit of land. This arrangement continued for about five years. A severe snow-storm with high winds and subsequent frost caused the pole to break, the wires falling over houses and back yards—altogether a bad mess. It was about Christmas time, and bitterly cold, with deep snow lying on the ground. No space was available for the erection of another pole near that which was broken, and it became necessary to ask the owner of the other strip to oblige by allowing a pole to be put up temporarily on his land. At first he was unwilling, but after long negociation he gave consent, on the condition that a payment of twenty shillings be made at once for one month's accommodation.

These terms had to be accepted, as no alternative was available.

I will close by saying that judgment, patience, tact, and courtesy on the part of those seeking wayleaves is very necessary.

I have known a lineman get consents when an engineer has failed, and an engineer get consent when the Superintending Engineering has failed, but good temper and conciliation generally succeed.

THE NATIONAL TELEPHONE CO. v. H.M. POSTMASTER-GENERAL.

On May 9th and for several subsequent days King's Bench Court No. IX—one of the Royal Courts of Justice—was crowded with telephone officials and bristling with telephones, switchboards, model villages, wires and cables. Under the Purchase Agreement of 1905—by which the Postmaster-General had agreed to buy the Company's plant, land, and buildings on December 31st, 1911—power was reserved to object in non-competitive areas to plant not constructed in accordance with an agreed specification, and in competitive areas, such as London and South Wales, to plant of any kind, whether constructed in accordance with the specification or not. Notices of objection had to be given by January 1st, 1911, and seventeen such notices, two relating to non-competitive areas and fifteen to competitive areas, had been served on the Company. The purchase agreement stipulated that if the Company objected to accept such notices they must obtain, before June 30th, 1911, an award in their favour from the Railway and Canal Commission, who were the appointed arbitrators. The Company accordingly made application, and the arguments were heard by the Commissioners: Mr. Justice A. T. Lawrence, the Hon. A. E. Gathorne-Hardy, and Sir James Woodhouse.

The counsel engaged in the case were: For the Postmaster-General, the Attorney-General (Sir Rufus Isaacs, K.C., M.P.), the Solicitor-General (Sir John Simon, K.C., M.P.), and Mr. Branson.

For the National Telephone Co.: Sir Alfred Cripps, K.C., M.P., Mr. W. O. Danckwerts, K.C., Mr. E. Forbes Lankester, K.C., Mr. Edward Morton, K.C., and Mr. H. H. Gaines.

Only one witness was called by each side, Sir Alexander Kennedy appearing for the National Telephone Company, and Major O'Meara, C.M.G. (Engineer-in-Chief), for the Post Office.

Sir Alfred Cripps contended that the notices were vague and not good in law, and, moreover, they included private wire plant which the Postmaster-General had agreed to buy, and that so far as the question of suitability was concerned the Company's plant would be suitable and could not be objected to. It was agreed in the first instance to seek a decision on these two points.

Space will not permit us to do more than cull one or two paragraphs from the 346 foolscap pages of evidence.

Sir A. Cripps stated that the Company's gross revenue for 1910 was £3,422,425 and that the staff numbered 18,000. Six hundred people—400 for the Company and 200 for the Post Office—were engaged in making an inventory of the plant. The Company had spent £16,000,000 on its plant.

Sir A. Cripps occupied the whole of the first day and the morning of the second, much time being devoted to the definition of a "telegraphic line." Mr. Danckwerts followed. Then the Attorney-General replied for the Postmaster-General and continued his argument on the morning of the third day. In the afternoon Sir John Simon followed, and a happy little illustration he used to clear up a point for Mr. Justice Lawrence, provided, perhaps, the only smile-raising episode of the nine days.

Mr. Justice Lawrence thought that "the actual requirements of the Postal service on December 31st, 1911," could have nothing to do with the National Telephone Co.'s plant, because it did not become the property of the Postmaster-General until January 1st, 1912, to which the Solicitor-General replied, "I hope your Lordship will not think I am putting a trivial illustration. I am only anxious to make my point plain. May I suggest this: if a barrister, who is going to be called to-morrow morning and is then going to argue his first case in court, walks into Eve's shop in Chancery Lane the night before, and says, 'I require a wig,' would Messrs. Eve be justified in saying 'You are not going to be called till to-morrow; you cannot require a wig?"

On the fourth day Sir Alex. Kennedy was examined by Mr. Danckwerts, and he explained details of a telephonic system by means of photographs and models. It was stated that the Company have 1570 exchanges; 498,261 exchange stations; 534,253 total stations; and 1,253,888 miles of wire. "Total stations" include "private wire" stations.

On the fifth day Sir Alex. Kennedy was cross-examined by the Attorney-General, and expressed his personal preference for the local battery system.

Major O'Meara was examined by Sir John Simon. He explained by means of working models the advantages of the central battery system as compared with the local battery or magneto system.

Various details of the Post Office system were explained at length for the benefit of the Commissioners.

Cross-examination by Sir Alfred Cripps ensued, and was continued into the sixth day. Information as to the rate of growth of the Post Office London system was called for, and it was shown that on December 31st, 1904, the Post Office had 21,912 stations in London, and on December 31st, 1910, there were 71,323, an increase for the period of 225 per cent.

The seventh and eighth days were occupied by further arguments of counsel.

Mr. Danckwerts handed in a paper showing that in areas in which there is competition between the Post Office and the Company there were on the Company's system 161,125 stations and on the Post Office system 81,110 stations as at December 31st, 1910.

Judgment was given on May 29th in the following terms:

Mr. Justice A. T. Lawrence: This case raises important questions under the Agreement of the 2nd February 1905, for the purchase by the Postmaster-General of the National Telephone Company's system. That agreement was come to under these circumstances.

The Company under a licence from the Postmaster-General had established a large business, and had in doing so afforded a great public convenience. This licence would expire upon the 21st December 1911.

The Postmaster-General had in 1901 commenced to afford a telephonic service.

This business had not in 1905 assumed its present dimensions. Since 1901 Postal Telephones have greatly increased.

The Agreement provided for the transfer of the whole system of the Company to the Postmaster-General at the expiration of the licence; it was to be transferred as a going concern, but on what are called "tramway terms"; the property to pass under the Agreement was to be "all brought into use with the sanction of the Postmaster-General and in use on the 31st December 1911." Stores and spare plant of all descriptions were to be included, provided they were reasonably necessary for the purposes of the business of the Company.

Clause 3 of the Agreement gave the Postmaster-General power to exclude from the purchase plant which he considered would be "unsuitable" for the postal service. He was to do this by a notice to be given to the Company not later than the 1st January 1911.

The clause provided that if the Company do not agree with the view taken by the Postmaster-General they must obtain from this Court, before the 30th June 1911, a decision that the plant objected to is "suitable," otherwise the Postmaster-General's objection is to prevail and the plant objected to be excluded from the sale. It will therefore remain the property of the Company.

There is a further provision enabling the Postmaster-General in the event of any plant being excluded from the purchase, to enter and substitute other plant for the unsuitable plant. The Postmaster-General has given 17 Notices of Objection under this section. These Notices are said to be bad in whole or in part, and we have to determine whether this is so.

It became evident at an early stage of the argument that the parties took different views of the meaning of the word "unsuitable." For the Postmaster-General it was contended that he could object to any plant that he did not want. The point is raised by the Application in paragraph 9 and the answer in paragraph 8. For the Company it was said that the clause had no such meaning, that it gave power to object only on the ground of the quality or character of the particular plant. At our suggestion this question was argued first.

The first thing that strikes one upon it is that the word "unsuitable" points more aptly to quality than to quantity; next it is surprising that a vendor who has to keep his plant in use in order that it should be sold at all, should agree to leave it in the hands of the purchaser to provide as much other plant as he pleases, which will thus exclude his property from even "tramway terms." The agreement seems to protect the Postmaster-General from having any excessive plant imposed upon him in very clear language—see the provisions as to stores, spare plant, and new exchanges in section 2.

It is quite true that the Company was a licensee only, whose property would be put out of use by the expiration of the licence. But he was a licensee who had performed a great public service, and who was ready to agree to tramway terms. What is now being done in providing new plant and new exchanges to take the place of the Company's plant is practically to "scrap" the Company's plant in the condemned exchanges. This does not seem to me to be just and I should require clear words to induce me to hold that such a power was intended to be conferred upon the one party to the Agreement by the other. The words do not seem to me to be clear; on the contrary, when all are read and each receives its natural meaning they fail to support the argument. It is quite true the words "actual requirements" in some collocations might mean real needs, but the telephone is a highly specialised instrument, and electrical science and its applications are constantly developing and producing new and ingenious devices, and I think the words "suitable to the actual requirements" of the service seven years hence may very well apply to the quality and character of the particular plant and not to the sufficiency of some other and different plant, viz., of the Postmaster-General to perform the functions of the Company's plant.

The argument for the Postmaster-General first assumed that "any kind" of plant meant plant of any quality, and not plant of any description or variety. Having made this assumption it proceeded to treat this as showing that the word "requirements" meant "needs" for "kind" had already dealt with quality. It then said the test of these needs must be what the Postmaster-General would want for the combined business of the Post Office and the Company. It thus arrived at the conclusion that any plant of the Company could be excluded from the purchase if the Postmaster-General had become possessed of other plant of a similar description sufficient to serve the purpose. So that however necessary the plant objected to may have been to the service of the Company, however high its quality and modern its type, the Postmaster-General could reject it. This seems to me a not very wise or very likely bargain for even a licensee to make, seven years before the expiration of his licence; but laying that consideration aside it is not the construction at all. When individual words may have two or more meanings you must not begin by assuming one meaning because it happens to suit you and disregard all others.

Further, you must not treat as pedantic and technical a reference to the exact meaning of other words in the sentence merely because they render your assumption impossible. This is what the argument does; it says the "actual requirements of the Telephone service of the Post Office on the 31st December 1911" means the prospective needs of the combined business of the Company and the Post Office on the following day. No reason is vouchsafed why this transposition should be made, but allusions to the public purse and the propriety of economy are gracefully substituted. With this provision the words of section 9 (1) of the London Agreement should be compared; there the date taken is "after" the determination of the licence, not before; even then I do not think that any idea of excluding duplicate or surplus plant is visible, but there is in the section now in dispute a clear change of language, and this should in itself have some intention attributed to it unless this can be clearly negatived by reference to other parts of the Agreement.

It was admitted that as applied to sub-clause (A) "suitable" referred to quality and not to quantity and this is clearly so, for in non-competitive areas, however excessive its quantity, all plant must be taken over if made according to schedule, *i.e.*, according to the "requirements" as then formulated. No explanation was offered satisfactorily to my mind why if this were so under (A) there should be a grouping of (A) and (B) together and an application of the same words but with a different meaning to (B); such grouping is only sensible and proper when it is made in order to apply one and the same proposition to both branches of the group. It is clear that when the parties to the Agreement had in mind any question of a surplus quantity they knew how to express their intentions in the plainest language—*see* section 2 (1) (D) as to stores and (2) as to spare parts.

There was an argument based on the use of the words "suitable to the requirements" in section 7 of the London Agreement which deserves notice for it seemed to me for a time to have some plausibility. It was urged that in that section these words had precisely the meaning sought to be placed upon them here, and that this Agreement was based upon that one. Upon consideration I think that the meaning attributed to the words in that section is reached by limiting the application of the word "necessary" which precedes them, and by ignoring the fact that the difference between one route and another is a matter of quality of route and not one of quantity or amount of anything.

The next matter for consideration is alleged invalidity of the Notices of Objection served upon the Company by the Postmaster-General. It was urged for the Company that these Notices were wholly bad on the ground of vagueness and generality, and we were asked to amend the prayer of the Application by deleting the words of exception therein contained. I think it would be proper to make this amendment, both upon the general principles applicable to the amendment of Pleadings and also because I think that the exception in question is well founded. The Notices are not wholly bad. There is no prescribed form of Notice, and a Notice is only bad upon the face of it when it fails to perform the functions for which it was required by the Statute or Agreement.

The purpose which a Notice was in this Agreement designed to serve was to inform the Company that the Postmaster-General considered certain property unsuitable, and that he proposed to exclude it from the purchase. The mere Notice effected its exclusion, unless the Company within six months obtained an award that it was suitable.

Any form of words which would enable the Company to take into consideration the question, and to decide whether it agreed with the Postmaster-General or differed from him would be sufficient. For if it agreed with him it could make arrangements for the sale of excluded property, and its removal in due course, and for the substitution by the Postmaster-General of other effective plant; or if it differed from the Postmaster-General it could proceed to have the matter decided by this Court. So long as the Notice was sufficiently specific to enable the Company and the Court to come to a conclusion upon the matter it would be sufficient.

That the property which it is proposed to exclude should be identified by the Notice seems to me to follow from the fact that it is a part which it suggests should be excluded from the whole; and this is supported by the language used in clauses 3 (1) and 3 (2). It is "such plant," etc., "as he considers will be unsuitable," and the award is to deal with that which has been "specified in the Notice of Objection."

The London Notice, Part 1, seems to me to comply with these requirements, though it may be that, before the question of fact as to whether the property mentioned therein is or is not suitable, some further particulars might be necessary. The same thing is true of the Abergavenny Notice and of other Notices. But when I turn to Part 2 of the London Notice, in so far as it purports to apply to plant other than that included in Part 1, it seems to me to be bad: it does not give one any idea of what plant it is, or where it is situate, except that it is in the London area. What it does is to give grounds of objection without stating the property to which they are alleged to apply. It is one thing to specify a piece of property to which you object, and another to specify a quality to which you object. Whether any particular piece of property is open to one or more of these grounds of objection, is a matter about which opinions differ, and until the property is identified the question can neither be considered nor determined.

The Notice relating to the non-competitive areas is bad for these reasons. It is no answer to say that it would have been difficult and troublesome to give a Notice mentioning the plant objected to. The difficulty of duly exercising a power is no excuse for not doing so if the rights of other parties are affected thereby. Here the Company disputes that any of its property is open to these defects. This form of Notice would exclude it all from the purchase unless and until the Company proved to the Court that each particular part had not the defect. This is to change the onus in a manner not justified by anything in the Agreement, and to read "such plant as he considers unsuitable" as satisfied by a Notice which is so framed because he does not know the facts and does not desire the trouble of considering them. This, although the Postmaster-General has the right under the Agreement to make the Company furnish him with all the information he may reasonably require.

Mr. Gathorne Hardy: I have had the opportunity of considering the judgment just delivered, with which I entirely agree. Having regard, however, to the importance of the matter, I desire to give quite shortly the reasons which have led me to the same conclusions. I need not repeat the history of the case, and those preliminary matters which have been so fully treated by the learned Judge. The most important point we have to consider is the one raised by the Postmaster-General in his letter of the 21st of October, 1910, in which he claims the right to object to plant, lands and buildings in competitive areas, otherwise than on account of its objectionable character, on the ground that he considers it will be unsuitable for the requirements of his telephonic service on the 31st December, 1911, because he will on that date be in possession of other sufficient plant suitable for the requirements of his service in the several areas in question. The Company contend that these words, quoted from clause 3 of section 1 of the purchase Agreement, refer solely to the character of such plant, land and buildings, and the question we have to determine is the true meaning of these words in this business Agreement, and whether it ought to be construed in the manner suggested on behalf of the Postmaster-General. Before considering the words themselves with their context, it is necessary to go back to the position of the parties on February 2nd, 1905, when the Agreement was made. At that time the Telephone Company were carrying on an enormous business, upon which a vast capital had been expended, under a licence of the Postmaster-General, which business would absolutely cease and determine on December 31st of the present year. The Postmaster-General was under no obligation to purchase any of the plant, which after that date would have no business value in any hands but his own. On the other hand, there was a strong reason to induce him to come to a sensible business arrangement in the matter, because in the interest of the public it was essential that the telephone service to which they had become accustomed should continue without a break, and this would have been impossible had the telephone licence been allowed to lapse, and the business to cease, without some previous arrangement between the parties. Under these circumstances the parties entered into the Agreement we are now called upon to construe, by which the Postmaster-General undertook to purchase all such plant and buildings as are thereinafter specified upon what are known as "tramway terms." I omit such provisions as refer to the private business and other excepted matters, with which we have nothing to do in the present proceedings. In substance, as I read the Agreement, the intention of the parties was that the Postmaster-General should take over everything not excepted by section 3, and the reason why the exceptions had to be dealt with six months in advance of the determination of the period during which the Company could transact business was to enable the Company to dispose of, and the Post Office to replace, all such plant as we may decide to be unsuitable, before the period of transfer. In the Agreement there are provisions to protect the Postmaster-General against having new land bought, or buildings erected without his consent, but if their construction of the Agreement is correct there was nothing to prevent them from diminishing their ultimate liabilities any time during the five years by starting a new exchange in any area side by side with that of the Company, and thus depriving the old one of all but a break-up value. Unless this meaning is clearly expressed I cannot think that it is likely that business people would have accepted such terms.

This brings me to the words of section 3. By subsection (A) both in competitive and non-competitive areas the Postmaster-General may object to all plant not constructed in accordance with the Schedule, and in competitive areas he may object to plant of any kind, irrespective of the Schedule if he considers that "it will be unsuitable for the actual requirements of the telephonic service of the Post Office on the 31st day of December 1911." On one construction of the words, if his contention is correct, this would exclude substantially all the plant of the Company in competitive areas, because he will not begin to serve their customers and subscribers until the 1st of January 1912. I do not, however, ground my opinion upon this construction, but upon my reading of the words themselves, which seem to me to be singularly inapt to bear the meaning which it is sought to place upon them. After giving my most careful attention to the arguments of the learned Attorney-General and Solicitor-General I cannot bring my mind to any other conclusion than that the words refer to the quality and character of the plant, land or buildings to be rejected, and are intended to protect the Post Office from having to take anything obsolete or out of date. We have had many illustrations of the rapid progress made in scientific invention which might call for such protection.

This brings me to the second point, that of the validity of the notices. As to these subsection 2 of section 3 makes it necessary for the Company to obtain our award before the 30th of June next, that any plant, land or building "specified" in any notice of objection will be suitable for the actual requirements of the telephonic service of the Post Office on the 31st of December, failing which the Postmaster-General will not be bound to buy "such" plant, land or buildings. I am of opinion that we ought not to hold, as Sir Alfred Cripps asked us to do, that the notices are wholly bad, or that because they are bad in part, that the good part cannot be separated from the bad. I do not think that the cases he cited, which refer to the special case of notices to quit, justify such a decision. The first part of the London notice seems to me to be sufficiently specific to identify the subject-matter, although we may need some more information to enable us to give our award; but in the second part it seems to me that the Postmaster-General has misapprehended the scope and intention of the provision under which they purport to be given. They seem to me not to "specify" the subject-matter, but rather to give the reasons for which certain parts of the Applicant's plant may be rejected as unsuitable. I really fail to see how we could give such an award upon these notices as would enable the Applicants to dispose of, or the Post Office to replace, the condemned articles before the date of transfer. It was strenuously urged upon us that the task of giving a detailed list would be impossible. No doubt it would be very difficult, but if that was the meaning and intention of the obligation it must be done by someone, and I do not think it was intended that the difficulty should be transferred to the Applicants. Every item of the plant, land and buildings will have to be put in a list before the ultimate valuation can be made, and I do not see any insurmountable difficulty in having determined beforehand, and identifying before giving notice, such portions thereof as it is sought for good and sufficient reasons to reject. Of course an objection to a class of articles might be sufficiently specific where there was no room to dispute whether a particular article did or did not come within the class, but short of this I do not think that such a notice would be sufficiently specific to enable the object of the notices to be carried out. I was at first inclined to think that the defect might be cured by particulars; but Sir Alfred Cripps pointed out that this would be in effect to give fresh notices where time was of the essence of the contract, and the Attorney-General agreed that we could not give any right to amend, or give particulars which would in effect extend the right beyond what it is under the literal construction of the paragraphs. For these reasons I hold that the first part of the London notice is good and the second bad. I confine my judgment to the London notices which seem to me to raise the points sufficiently to enable the parties to ascertain their position.

Sir **James Woodhouse**: Two preliminary questions of great importance are raised by this application. The first question is whether the notices, which have been given by the Postmaster-General under the agreement of purchase between him and the Company whereby he objects to take over from the Company certain plant and buildings belonging to them, are in whole or in part invalid. The other question involves the determination of what plant, land and buildings the Postmaster-General is entitled to exclude from the purchase.

I think it not unimportant for a proper appreciation of the points at issue to glance shortly at the history of the matter and at the relative position of the parties in reference to the telephonic business.

The public telephonic business of the Telephone Company has been carried on all over the United Kingdom under a licence from the Postmaster-General, dated the 29th November 1884, and in respect of it the Company have paid a royalty of 10 per cent. of the gross receipts amounting to a very large sum.

This licence (except with regard to five places where it was extended for varying periods because a competing municipal licence had been granted to them under the Act of 1899) will expire on the 31st December 1911.

By the terms of the licence the Postmaster-General was empowered on notice to acquire the business of the Company compulsorily at certain stated intervals on arbitration terms. This power was never exercised. In 1896 the trunk wires were taken over by the State. As a result of a long enquiry in Parliament in 1898 the Postmaster-General, who had up to that time conducted telephonic business in a few places in a half-hearted and ineffective way, determined to enter upon active competition with the Company on commercial lines and announced his intention of taking over the control of the entire telephonic business of the Kingdom on the expiration of the Company's licence in 1911. He commenced with London where the Company had in operation a very extensive business.

The Company's business was carried on entirely by overhead wires and voluntary wayleaves. The Company had not the statutory powers possessed by the Post Office of laying underground wires. It was important to the Postmaster-General in starting a new business of this character, with a limited number of subscribers, that he should be able to secure for them communication in the same area with the subscribers of the Company, and it was important to the Company that they should be able to have the use of wires which the Postmaster-General could lay for them underground, and to avail themselves of wayleave rights which he could enforce and they could not, and also exchange facilities for trunk messages in connection with the Post Office, not only in London but throughout the country. These and other facilities mutually advantageous were arranged and embodied in an agreement dated 18th November 1901, known as the London Agreement.

By clause 9 of the agreement the Postmaster-General undertook to buy, on the 31st December 1911, "all such plant as was at the date in use by the Company for the purpose of the Company's London system, and as was suitable for the actual requirements at the date of the telephonic service of the Post Office within the London area on what are known as 'tramway' terms." The Agreement defined what plant would come within its scope, and referred disputes to arbitration. It applied to the London area only. This area included "greater London," and comprised a population of over six millions; and in this area the Postmaster-General established his own service, largely underground, in competition with the Company. As to the rest of the United Kingdom at this time, viz., 1901, the only provision for the purchase of the Company's business was the optional purchase power given to the Postmaster-General by the original licence. This expired in 1904, never having been exercised. Therefore, in 1905, the parties stood in this position :—

The Company's business would come to an end in 1911. There were 400 exchange areas outside the London area in which the Postmaster-General had no alternative exchanges, and to enable him to carry on the business with efficiency at the end of the Company's licence, he had to determine whether he would embark on the enormous outlay required for this purpose or come to terms with the Company to utilise their exchanges. The Company, on the other hand, in the uncertainty as to what was to happen in 1911, were in the precarious position of being unable to make with prudence any great capital outlay necessary to meet the daily increasing requirements of the public. The outcome of the negotiations was a new Agreement dated 22nd February 1905. So far as its purchase clauses are concerned it cancelled and superseded the London Agreement and brought within its purview the business throughout the Kingdom.

By Clause 2 of the Agreement the Postmaster-General agreed to buy, speaking generally, the plant, property and assets of the Company brought into use with his sanction, and in use by the Company on the 31st December 1911, for the purposes of its licensed business and also the private wire or unlicensed business with its plant and property in use on that date. The price was to be ascertained as to the licensed business by valuation on tramway terms, *i.e.*, without any allowance for goodwill, but in the case of the private wire business, goodwill was to be allowed for on a fixed basis of three years' net profits.

We then come to Clause 3, under which the points in controversy have arisen. Sub-clauses (1) and (2) are the material portions and read as follows: "(1) In the case of: (*a*) Plant not constructed in accordance with the specification and rules set forth in the Third Schedule hereto (other than switchboards and internal exchange plant in use on the 15th day of August 1904, and specified in a list furnished by the Company to the Postmaster-General within six months from the date of this agreement), and (*b*) Plant of any kind, land and buildings in use on the 1st day of January 1911, for the purposes of the Company's licensed telephonic business in competitive exchange areas (whether such plant is constructed in accordance with the said specification and rules or not) the Postmaster-General may by notice in writing given to the Company not later than the 1st January 1911, object to buy such plant, land or buildings as he considers will be unsuitable for the actual requirements of the telephonic service of the Post Office on the 31st day of December 1911." (2) Sub-clause 2 provides for referring any question raised by the Postmaster-General under last preceding sub-clause to us and stated that if the Company fail before 30th June next to obtain an award to the effect that any plant, land or building specified in any notice of objection will in the opinion of the tribunal be suitable for the actual requirements of the telephonic service of the Post Office on the 31st day of December 1911, the objection of the Postmaster-General shall be deemed valid and he shall not be bound to buy such plant, land or building.

Prior to the 1st January last the Postmaster-General gave notices to the Company pursuant to the above clause that he objected to buy certain plant, land and buildings mentioned therein. These notices relate both to competitive and non-competitive areas. It was argued on behalf of the Company that they are wholly void and cannot be acted on, because they are vague and indefinite and do not enable the Company or the Court to identify specifically what is objected to.

Sir Alfred Cripps, on behalf of the Company, supported his argument by a detailed criticism of the first notice which related to the London area. The Company have in this area 63 exchanges. Twelve of these are in the Metropolis and 51 are in the suburbs. Of the 12 in the Metropolis the Postmaster-General objects to 3, viz.: the Avenue Exchange in Lime Street, the Bank Exchange in Queen Victoria Street, and the Westminster Exchange in Northumberland Avenue, and of the 51 outside he objects to 18. In form the notice is that the Postmaster-General "considers that the plant, land and buildings described in the schedule hereto and now in use for the purposes of your, the said Company's, licensed telephonic business in the competitive area of London will be unsuitable for the actual requirements of the telephonic service of Post Office on the 31st December 1911 and that the Postmaster-General objects to buy such and so much of the said plant, land and buildings as is so in use on the 1st January 1911." The schedule is in two parts, in Part 1, as regards land and buildings, each exchange is named and its situation described, and, as regards plant, the description is (*a*) the exchange equipment, in each of the said exchanges, (*b*) all telegraphic lines connecting any exchange subscriber's office or call office or other exchange with any of the said exchanges, or any one of such exchanges with any other, (*c*) all apparatus fitted in any exchange subscriber's office or call office connected with any of the said exchanges.

Major O'Meara, the Engineer-in-Chief of the Post Office, in his evidence stated that these exchanges were objected to as unsuitable on the ground that they were on the magneto system, as distinguished from the Central battery system, which is the system adopted both by the Post Office and by the Company in their most recently constructed exchanges.

The relative advantages and disadvantages of these systems were illustrated and explained, and we have seen them in operation. It is admitted that the Central battery system, is at all events in the larger exchange, much the better of the two, though probably it entails a larger capital outlay.

The Notice raises and was obviously intended to raise the Postmaster-General's claim to reject as unsuitable for his service the entire exchanges and all the equipment, such as switchboards apparatus and all wires connecting the subscribers with the exchange, or the Exchange with any other Exchange. Whatever judgment we come to after investigating on their merits the subject-matter of this Notice I can see no ground for saying that the Notice itself is vague or indefinite. I think it would have been difficult to make it more specific, and I am of opinion it is sufficient for the purpose intended and that it is not invalid.

It was then argued that the Notice was separable, and though it might be held sufficient as to Part 1 of the schedule, it was ineffective and void as regards Part 2.

Part 2 relates to all plant other than what is referred to in Part 1.

I take the first paragraph which is typical of the remainder. The Postmaster-General objects to take "all telegraphic lines connecting any exchange with any subscriber's office or call office or other exchange and not consisting of or forming a complete metallic circuit."

As I understand the argument, the Notice as to this is bad in form, because its language is generic instead of specific. It does not, it is said, bring home to the mind of the Company's officials, as a proper Notice should do, what it is the Postmaster-General desires to exclude, with sufficient definiteness to enable them to determine whether to acquiesce in it or to dispute it. It should, it is argued, have stated how many lines and what they are. With great deference, I am unable to accept this view.

What the Postmaster-General is here notifying is that he objects to take over as unsuitable all lines which do not form a complete metallic circuit.

By the Third Schedule of the Agreement (which deals with the specification and rules as to plant), Clause 2, it is provided: "All circuits, whether exchange, subscriber's circuits, or junction circuits, shall be metallic."

Every telegraphic engineer knows what a metallic circuit is, and what lines under his control constitute a metallic circuit. The Company's engineer can indentify at once the lines which come within this description and what precisely the Postmaster-General is objecting to take. The facts as to what particular lines do not conform to the requirements in the specification and are within the objection of the Postmaster-General are in the knowledge of the Company. Suppose the provision as to Notice had referred to staff instead of to plant, and the Postmaster-General had given notice that he objected to take all who were over 60 years of age, I cannot see how such a Notice could be treated as invalid because it failed to set out specifically the names and descriptions or number of men alleged to come within the disqualification, but only referred to them as coming within a particular category. The Company can be left in no doubt as to who come within the excluded class. So the class and description of the plant objected to are stated in this Notice and the ground of objection is indicated. Whatever comes within the description is excluded subject, in the case of dispute as to suitability, to the decision of this Court. Further particulars appear to me to be the subject of evidence, and this Tribunal with all the machinery for discovery at its command, can, if it be reasonable, enforce any detailed information which ought to be furnished. I need not go through the remaining paragraphs of the schedule. We have had the evidence of the Engineer-in-Chief of the Post Office about them, and after considering such evidence, my view as to the first item applies also to them. I think from the business point of view, it would be misreading the true intention of this Agreement to hold that this Notice was so imperfect as to render it invalid, and that complete justice can be done between the parties on the merits, without placing that technical interpretation upon it.

The next point deals with the plant, etc., which the Postmaster-General may exclude from the sale. By clause 3 he may object to buy such plant, land, or buildings as he considers will be unsuitable for the actual requirements of the telephonic service of the Post Office on the 31st December 1911. This clause qualifies clause 2 and limits the Postmaster-General's obligations. It is contended for the Company that "unsuitable" here refers solely to the character or kind of plant, and not in any sense to the quantity of the plant that may be rejected. If the word "unsuitable" stood alone, I should find it less difficult to accept the narrower interpretation; but when taken in collocation with the words which follow, I think it has, and according to the scheme of the Agreement was intended to have, a quantitative as well as a qualitative meaning. The circumstances must be considered. Sub-clause (*a*) of clause 3 refers to plant only, and deals with non-competitive areas. The Postmaster-General may object in these areas on the ground of unsuitability to any plant not in accordance with the specification in the Third Schedule. That schedule deals with the character only of the plant, and on that ground alone would the Postmaster-General have any occasion to object. His quantitative requirements arising from competition do not here come into consideration. He is bound to take over the entire exchange, with the reservation that he may object to plant belonging to it which he finds to be not properly constructed or up to date. That is his only concern. The test is the Postmaster-General's requirements, in other words, his "needs"; and the standard of suitability for his actual requirements in the circumstances of these areas is the character or quality of the plant.

But sub-clause (*b*) deals with competitive areas where the circumstances are, from the nature of things, different from those in non-competitive areas. In some of these areas the Postmaster-General has acquired land, and erected buildings and established exchanges of his own, overlapping those of the Company. These have been constructed in the last nine years on the central battery system with the most up-to-date plant on the most improved method of working, with the avowed object of carrying on the service in competition with the Company, and superseding its exchanges where they were not required. In such areas it must have been patent in 1905 that there would be in 1911 duplicate exchanges; and it appears to me that sub-clause (*b*) (which deals not only with plant, but also with land and buildings, and in the case of plant, where it is or is not of the character required by the scheduled specification) in giving the Postmaster-General the right to object to any of these on the ground of unsuitability for his actual requirements, contemplated and provided for unsuitability from the point of view of quantity as well as quality.

I think "requirements" here means "needs" and "actual" refers to those at the time of transfer in contra-distinction to the requirements of the future. If, at the prescribed period, the Postmaster-General's exchange in any competitive area will be sufficient or adequate not only for the then existing subscribers of the Post Office, but will also efficiently accommodate the Company's subscribers in the same area, I think the words mean and were intended to mean that the existing exchange of the Company might be objected to as unsuitable for his actual requirements. The test appears to me to be the Postmaster-General's needs. It becomes unsuitable for his actual needs, if it can be shown that he has no need for it at all, and that the purposes of the postal telephonic service with the added subscribers of the Company will be adequately met by the then existing exchange of the Post Office. I see no inconsistency in reading unsuitability for the Postmaster-General's requirements as applying differently in sub-clause (*a*) from sub-clause (*b*) as the circumstances of its application are different.

Let me illustrate the position the Postmaster-General takes up. He objects to the Company's Avenue Exchange, Lime Street, in the City of London. It has 4000 or more subscribers. The telephonic system in operation is what is known as the local battery system. Within a short distance the Postmaster-General has a very extensive exchange known as the Central Exchange in Carter Lane near St. Paul's. There are about 19,000 subscribers connected with the exchange, and lines now existing for connecting 25,000 subscribers. Within 400 yards also of Lime Street the Postmaster-General has constructed another new exchange in St. James's Place, which will be opened very shortly and before the date of transfer.

The question is whether, if he can show that the equipment, plant, and apparatus of the postal telephonic service in his own exchanges will at midnight on the 31st December 1911 amply accommodate and give an efficient service on the best system not only to his own but also to the Company's subscribers whom he is bound to take over, he can reject the Company's exchange as surplusage, because he has in fact no need for it, and therefore such plant and buildings become unsuitable for his requirements. The plant and buildings must not only be suitable, but he must actually require them. If the Company dispute the Postmaster-General's notice, then they have, by the Agreement, to obtain an award from us, after an investigation of the facts, that what is objected to is in fact suitable, in other words, that the Postmaster-General has not good ground for his objection. "Suitable" is defined by the Imperial Dictionary as meaning not only fitting but "adequate." Adequacy is a quantitative expression, and the moment it appears that this meaning can be assigned to the word, I think, taken in conjunction with the remaining words, we are precluded from restricting it within the limits contended for by the Company's counsel. Sub-clause 4 of this section, I think, strengthens this contention, for by it the Postmaster-General may even object to plant constructed and to land and buildings acquired or constructed in 1911. As by sub-clause 3 (*b*) of clause 2 such plant would have to be constructed according to the third schedule, and, therefore, by reason of its recent construction, would presumably in itself be unobjectionable in point of character and quality, it would seem that the Postmaster-General's objection must have reference to some other ground, and I think it points to the conclusion that it was to be open to him to object, that his needs would be sufficiently met by the provision he had himself made. For these reasons, with great deference and with the utmost respect for the different view taken by my colleagues, I think on both the questions submitted for our determination the Postmaster-General is entitled to judgment.

Notice of appeal was given, and the appeal was heard on June 14th and following days by the Master of the Rolls, Lord Justice Farwell, and Lord Justice Kennedy. Judgment was given on June 28th in accordance with the finding of Sir James Woodhouse, and the costs of the appeal were ordered to be paid by the National Telephone Company.

OUR LIBRARY AND ONE OF THE BOOKS.

How many of our readers have ever been in our Library? Not a great number, I am sure. I feel sure, also, that when the reader in far Cathay comes across this reference to the Library of the Institution of Post Office Electrical Engineers, which is located in one of the magnificent buildings of the Post Office, St. Martins-le-Grand, London, at the very heart and centre of the British Empire, there will spring into his mind the picture of a spacious room lined with book-shelves, a soft and silent carpet, on which are spread about—like islands in a summer sea—roomy and comfortable chairs, whose occupants are engaged in assimilating the concentrated essence of the world's latest contributions to electrical science, for the purpose of aiding them in their duties as Headquarters officers of the Engineering Department of the British Post Office.

It is a fair vision, and it seems a pity to disturb it. Only respect for the truth compels the sacrifice. I well remember, at the birth of the Institution in 1906, when Sir (then Mr.) John Gavey laid before the then President and Secretary of the Society of Post Office Engineers the Department's proposals, which included the setting aside of a room to be used as the Library of the Institution —it was just this sort of vision which rose in my mind. Full of hope, the first members of the Council purchased a handsome suite of sectional book-cases. Disillusion soon came. The first home of the Library was a corner of a large room in King Edward Street, dark and uncomfortable; from there it was removed to an equally dark and unsuitable room on the first floor in the General Post Office (West), and thence to the position it now occupies on the ground floor near the Roman Bath Street entrance. In its present home the conditions are tolerable *by contrast* with what has preceded it, but the room is occasionally invaded and used for other purposes, to the great inconvenience of the Librarian and the consequent impeding of his most useful functions. There are sinister rumours that another of the periodical treks is impending, and that the Library will be again relegated to the dark room on the first floor,* so that the realisation of my dream of what the Library might be seems to be further off than ever.

I do not wish to impute blame to anyone, least of all to Sir John Gavey, who has always taken a living interest in the Institution and its progress. I am quite convinced that Lord Stanley, Sir Henry Babington Smith, and Sir J. C. Lamb, who, along with Sir John Gavey, were responsible for the origination of the Institution of Post Office Electrical Engineers (I wonder which one of them was the actual father of the scheme ?), intended that a dream like mine should materialise, but I cannot help wondering why, in this one respect, there has been failure. After much cogitation I have concluded that it is due to the too rapid growth of the Engineering Department *and the absence of a development study*. After all the Library is not the only case in which, with advantage, the accommodation might be improved.

In its practical, apart from its æsthetic, aspects the Library is unique, and has been an undoubted success. It contains about 1000 of the best modern technical books, and these are available for members of the Institution on demand. Moreover, there are no time limits or fines to worry the readers. The Librarian has a card for each book and a card for each member, so that he can always tell at a glance where a given book is or what books are in the possession of a particular member. The desire of the Council is that the books shall be in the hands of the members instead of reposing on the Library shelves. If a request is received for a book of which no copy is available, an intimation is sent to a member who has been long in possession asking him to return the book, and the necessary transfer is soon effected. Many of our members are regular readers, and must, like myself, have found the Library a great boon. On the other hand, I have been surprised to find that there are some, who have been members from the very founding of the Institution, who have never yet sampled the wonderful fare which the Library provides.

---

* This note was written for our April issue, but owing to want of space had to be held over. In the interval the blow has fallen !—ED.

This brings me to the second part of my title. I have just finished reading—in odd half-hours squeezed out of very busy days and nights—a book which, it seems to me, would prove irresistibly attractive if only its existence were known, and in return for the pleasure it has given me I hope to secure for it a waiting list of would-be readers. It is entitled 'New Conceptions in Science,'* by Carl Snyder, with the graceful dedication, "For the Friendship of my Mother," and it contains a series of essays on subjects of captivating interest to readers with a scientific bent. I quote from the contents:

ON THE RELATIONS OF SCIENCE AND PROGRESS.—The great school of science at Alexandria, 300 B.C., and its relative failure through the lack of accurate instruments, or appreciation of mechanical devices—The intimate relations of mechanics to modern civilisation—The present achievements of the scientific method—The *rôle* of science in the future; its aims, its task.

THE WORLD BEYOND OUR SENSES.—Researches which reveal how little we know of the real world around us, as it is presented to us by our primitive senses—How these primal senses are being extended, and new senses are being added.

THE FINITE UNIVERSE.—The facts which indicate that the stellar universe is not "infinite," but of definite size, shape, and mass, measurable and weighable—The means by which its boundaries are being fixed and its form determined, and the inferences that may be drawn from our present knowledge.

WHAT THIS WORLD IS MADE OF.—The limits of the divisibility of substances, and the conclusions to which the study of their limits has led—What familiar things like soap-bubbles and gold-leaf may tell us of the size of molecules and atoms.

PROGRESS TOWARDS AN EXPLANATION OF ELECTRICITY.—Benjamin Franklin's ideas, and how they seem, in the light of recent developments, to offer the best explanation of this mysterious "fluid"—The electrical atom.

THE SEARCH FOR PRIMAL MATTER.—What are the atoms made of?—A detailed account of the ingenious experiments of Sir William Crookes, Professor J. J. Thomson, and others, disclosing the existence of particles of matter a thousand times smaller than the smallest atom—The nature of these "corpuscles."

THE RISE OF SYNTHETIC CHEMISTRY AND ITS FOUNDER.—The fertile career of M. Berthelot, the greatest of living chemists—What he has accomplished; what he hopes synthetic chemistry may do.

BORDERING THE MYSTERIES OF LIFE AND MIND.—The remarkable discoveries of Professor Loeb, of artificial parthenogenesis, and the relations of electricity and the life-processes—Professor Albert P. Mathew's experiments on the nerves, and his explanation of nervous action.

---

* 'New Conceptions in Science.' By CARL SNYDER. London and New York: Harper & Bros., Publishers, 1905. There are excellent portraits of Röntgen, Kelvin Crookes, J. J. Thomson, Hertz, Lodge, and other scientists.

THE NEWEST IDEAS AS TO WHAT IS LIFE.—Recent investigations which seem to show that life is a form of fermentation—The *rôle* of the ferments or enzymes in the bodily functions—The possibility of reversing the life-processes, and growing backward.

HOW THE BRAIN THINKS.—The chemistry and structure of the brain, and how recent discoveries are being applied to an explanation of the physical process of thought.

THE WAY THE HUMAN BODY FIGHTS DISEASE.—The discovery of the serums or antitoxins by Pasteur and his pupils—Metchnikoff's theory of the devouring cells, and their battles with the microbes—The new chemical theories of Ehrlich.

THE SPIRIT RAPPERS, THE TELEPATHS, AND THE GALVANOMETER.—The light that modern science may throw on psychic problems—A description of marvellous new instruments of measurement, which are thousands or millions of times more sensitive than our primal senses—The argument that might be drawn from some of their performances.

WIRELESS TELEGRAPHY.—The discoveries which made it possible, and a description of the apparatus used.

AMERICA'S INFERIOR POSITION IN THE SCIENTIFIC WORLD.—A review of the newest acquisitions to human knowledge, and the men and the countries that are foremost in this work—The astonishing activity of Germany and other European countries, as compared with America—The work of the Royal Institution of London, the Pasteur Institute in Paris, and the need of such research institutions in this country.

I have given it almost *in extenso*. I think you will admit it would have been difficult to leave out anything. Had I the pen of a certain well-known writer of the day I should be able to convey to you some impression of the pleasure I have derived from reading such a clear and delightful account of the advances made during recent years along these alluring scientific paths by workers in many lands. I have to confess that the title of the final essay first caught my eye, and that, like the novel-reading young lady, I began at the end. It was refreshing to read in an American book a glorification of things English and German. It is nice to read that "in England, where the public telegraph is not run to enrich rich people, it is possible to send a twelve-word message to anywhere in the kingdom for 6*d*." "From New York to Tacoma, ten words cost a dollar."

Far more space than is available would be necessary if I were to give way to my inclination to quote passages of absorbing interest which have roused my attention. I must content myself with a few phrases:

"The last two or three centuries have acquired a wider knowledge of this world and of the larger universe than all the sixty or a hundred centuries preceding. Whence come the great strides of the last ten or twelve generations? The cause may be summed up in a word—"the invention and use of mechanical appliances." "Waves of light are measured in micro-microns, that is, in units of about one twenty millionth of an inch. The rays visible to us lie between 380 and 610 of these units. It is possible to detect invisible rays that have only a quarter of this length, while at the other end of the scale heat-waves can be measured up to a length of 70,000 micro-microns. How small is the portion of the scale visible to our unaided sense."

"It is with difficulty that we realise a change in temperature until it amounts to several degrees on a thermometer; the bolometer will register a change in temperature of one millionth of a degree centigrade. It will register the heat of a candle a mile and a half distant."

The spectroscope, X rays, smoke-rings, the triumphs of the telescope and microscope, cathode rays, soap bubbles, tenuity, capillarity, atoms, and electrons, the infinitely distant and the inconceivably small, all are treated in a way which keeps the interest of the reader enthralled from cover to cover, and displays on the part of the writer knowledge both deep and wide, and a power to make broad generalisations and striking comparisons.

In such a book one does not look for humour, but humour is sometimes found in strange places. In the essay on "The Newest Ideas of Life," we are solemnly told that "life is a series of fermentations." From the bottom of my heart I concur.

D. H. K.

NOTES AND COMMENTS.

THE BRITISH SCIENCE GUILD.

At the annual meeting held at the Mansion House on April 7th, under the presidency of the Lord Mayor, the following gentlemen were elected as vice-presidents of the Guild: the American Ambassador, Sir Thomas Barlow, K.C.V.O., F.R.S., Sir Lauder Brunton, Bart., F.R.S., Sir Ernest Shackleton, C.V.O., and Major O'Meara, R.E., C.M.G.

The membership of the Guild, including the Canadian branch, has increased from 793 at the end of 1907 to 872 at the end of 1910.

WIRELESS INTERFERENCES.

ON Thursday, April 6th, a paper was read before the Institution of Electrical Engineers by Mr. J. E. Taylor, entitled "Wireless Telegraph Working in Relation to Interferences and Perturbations."

The author divided the disturbances into five classes: (1) Extraneous noises; (2) local induction influences; (3) interference from other stations; (4) atmospheric electrical disturbances; (5) variations in the wave-propagation efficiency of the medium.

It was pointed out that (1) can be avoided by careful selection of the site, and that (2) can be eliminated by special attention to neighbouring telegraph circuits. These should be led into wireless stations by a short length of underground, the internal wiring should be twin throughout, the wireless and ordinary earths should not be in too close proximity, main and local batteries should be well insulated, and sparking eliminated at all contacts.

In regard to (3) it was pointed out that interference between stations on different wave-lengths arises mainly from deformation of wave form due to blunt tuning at the transmitter; in some systems the long spark-gap inserted in the aërial makes for the establishment of high potential in the aërial prior to discharge across the gap. Such systems are very interfering, and the author attributed the effect to a forcing action at the transmitter.

The author went on to point out that a high degree of selectivity is obtained by loosely coupled transmitters, with the consequent purity of wave form, and also that a slightly damped receiver is much more sensitive than one moderately damped. Although moderately blunt tuning is essential for establishing communication between ships on various wave-lengths and the shore stations, there was no insuperable difficulty in arranging for loose coupling and sharp tuning at both transmitting and receiving stations once communication is established. The author described the Marconi multiple tuner, in which this is provided for so far as the receiving station is concerned, and went on to advocate the adoption of an equivalent device for varying the coupling at the transmitter; once communication is established the coupling at the transmitter would be reduced in proportion to the distance over which communication was taking place; interference between different stations would no doubt be minimised by its adoption.

Charts giving the results of simultaneous observations of atmospheric electrical disturbances taken over a period of one week at our coast stations were shown; from these it would appear that periods of pronounced disturbances were common to all the stations at one time. Tuning offers little solution to the elimination of the disturbances, as they act upon the aërial as forced oscillations. The use of long, light aërials for receiving only, with consequent heavy damping of such oscillations, was suggested as a possible remedy.

In regard to variations in the efficiency of the medium, instances of "freak" communications, mostly occurring at night, were cited, but it was pointed out that, so far as deleterious effects of the variations were concerned, coast stations with range up to 200 miles were but little affected.

AUTOMATIC TELEPHONE EXCHANGE SYSTEMS.

A large gathering of telephone officials listened with much interest to an excellent paper on the above subject, which was delivered by W. Aitken, M.I.E.E., of the British Insulated and Helsby Cables Co., at the Institution of Electrical Engineers on May 18th. A working exchange was exhibited. The discussion was unfortunately shorn of much value by the fact that most ot the speakers had been engaged on that day and previous days at the Law Courts on another matter which had absorbed all their energies.

EXTENSION OF SIR OLIVER LODGE'S PATENT FOR SYNTONISED WIRELESS TELEGRAPHY.

Grant of extension of the normal fourteen years' life of patents is only made in Great Britain in exceptional cases. It is necessary in the first place that the patent shall have sufficient merit and utility, and in the second place it must be shown that the patentee has not received adequate remuneration therefrom. This privilege has been accorded to the Lodge-Muirhead Wireless and General Syndicate on account of Sir Oliver Lodge's patent No. 11575 of 1897, for a period of seven years, as the result of a petition heard before Mr. Justice Parker. In the extended patent certain claims have been excised. Its scope will doubtless be somewhat curtailed thereby; nevertheless it is a matter upon which Sir Oliver is to be congratulated in view of the recognition which his pioneer work in wireless telegraphy has at last received. History is rapidly being made and unmade so far as the share taken by individuals in the development of wireless telegraphy is concerned. An interesting position has now arisen in virtue of recent legal decisions which will doubtless provide an additional spice of flavour to any further wireless litigation.

NEW WIRELESS JOURNAL.

The advent of a new monthly periodical devoted to the chronicling of matters connected with Wireless Telegraphy is to be recorded. The 'Marconigraph,' as the journal is termed, made its first appearance in April, and is published monthly by Marconi's Wireless Telegraph Company, Limited, at the very moderate price of 2*d*. per number. It combines features of commercial and educational interest. Several articles of a highly practical nature have already appeared. These are to be particularly welcomed, as there is great dearth of really practical information on current work in wireless telegraphy. The venture has our good wishes for its future welfare.

ABOUT OUR JOURNAL.

We take this opportunity to again thank the many writers who are contributing so ably and generously to our pages. We think it our duty to tell them that their work is being appreciated, and that letters—congratulatory and complimentary—come to us from editors and officials in various parts of the world. At the same time, we would ask those whose articles—although approved and accepted some time ago—have not yet been published, to accept our apologies for the long delay, and to believe that we are doing our best with the means at our disposal. It is to some extent out of consideration for their feelings that we are increasing the size of this issue by 20 per cent., but still more because we believe our readers will appreciate our continued efforts to increase the value and usefulness of the JOURNAL, and will mark their appreciation by bringing it under the notice of their friends. It is, of course, well known that there is a close and direct relationship between the circulation and the cost of production of a journal. As the circulation increases, the cost of production per copy decreases, and, as our readers are already well aware, we have given them the benefit of our increased circulation by increases in the number of pages and illustrations. We believe this is the right policy, and we are anxious to pursue it. It can, however, only be done with the co-operation and assistance of our readers, who will, we think, be interested to know that (*a*) a sufficient supply of new and interesting articles comes to us quarterly to permit of over a hundred pages per journal being printed, and (*b*) the present circulation is just sufficient to allow of ninety-six pages per quarter. We would say, further, that while the position of the JOURNAL is at present satisfactory, both from the financial and other points of view, we are anxious to improve it in every way possible, and that any suggestions or *criticisms* will be welcomed, and receive the most careful consideration of the Board of Editors.

INSTITUTION NOTES.

COUNCIL.

THE twenty-eighth meeting of the I.P.O.E.E. Council was held at Newcastle-on-Tyne on March 28th and 29th, 1911, A. J. Stubbs, Esq., in the Chair.

This being the last Ordinary Council Meeting for the session the

Annual Reports from the Library Sub-committee, the Board of Editors of the JOURNAL, the Treasurer and the Secretary were received, and after full discussion the Council's Annual Report drafted for presentation at the Annual Meeting of members in London on April 24th.

The following items of business were included in the agenda:

CONTRIBUTIONS TO JOURNAL FROM CLERICAL MEMBERS.—The Council are hopeful that the recent invitations for papers on clerical subjects will meet with hearty response.

PRINTED PAPERS.—Mr. Gunton's paper on "The New Power Station at Blackfriars" was passed for printing, as also was Mr. Lawson's on "Automatic Telephony." It was agreed that Mr. H. O. Fleetwood's paper on "Power" should be printed in the annual volume.

TECHNICAL PERIODICALS.—The voting of members in this matter was: Forty-four in favour of total abolition, 315 in favour of reducing the number of periodicals to one per member; 93 in favour of the existing distribution with increased circulation lists; 23 voted in favour of no change being made.

In view of the preponderating number of votes in favour of the reduction, the Secretary was instructed to take the necessary steps to bring the rearrangement into force as soon as the existing contracts for the supply of the various publications expire.

CLERICAL REPRESENTATION.—No objections having been raised to the proposed amendments to Rules 9, 11, and 16, providing for an additional provincial clerical representative on the Council, the alterations were authorised.

DISCUSSIONS ON PAPERS.—It was agreed by the Council that it would be of advantage if the permanently valuable portions of the discussions following the reading of papers could be preserved. With this in view it was decided to empower the Local Committees, when recommending papers for printing, to submit any notes of the discussion which they may deem of sufficient interest to be printed with the paper or, separately, in the annual volume of Abstracts.

INSTITUTION MEDAL AWARDS.—It was agreed that the question of the award of medals should be deferred until all the papers submitted during the session had been before the Council.

PRESIDENT'S AWARD.—The adjudicators have awarded the Engineering Prize to Mr. R. Bradfield for his paper on "The Theory of Central Battery Telegraphs," and the Clerical Prize to Mr. R. J. Smith for his paper on "District Accounting in the Post Office Engineering Department."

MEMBERSHIP.—The statement of membership up to March 24th, 1911, was as follows:

Number on Roll, March 31st, 1910		831
By resignations, Home	15	
„ Foreign and Colonial	1	
By retirement, transfer, or death, Home	11	
„ „ „ Foreign and Colonial	1	
	—	28
		803
New members, Home	39	
„ Foreign and Colonial	9	
	—	48
Number on Roll, March 24th, 1911		851

Members of the Council were favoured by the opportunity of being present on March 28th at the lecture entitled "Disturbances and Perturbations in Wireless Communications," delivered by Mr. J. E. Taylor to the Newcastle Branch of the Institution of Electrical Engineers. On the 29th the Council were present at the local meeting of the I.P.O.E.E., when Mr. H. Kitchen presented a paper entitled "Some Notes on Building Construction," and after the final session on the same date they were privileged to meet the members of the Northern Section at their annual re-union.

A brief Council Meeting was held at the Institution of Electrical Engineers, Victoria Embankment, London, W.C., prior to the Annual General Meeting of the Institution on April 24th, 1911. The usual printed report of this latter meeting will be duly circulated to all members of the Institution.

LOCAL CENTRE NOTES.

NORTH-WESTERN DISTRICT.

THE sixth and last meeting of the Session was held on March 20th. After the minutes of the previous meeting had been read and passed, a letter from the Secretary of the Manchester Section of the Institution of Electrical Engineers was read inviting the members of the local centre of the I.P.O.E.E. to attend a lecture by Prof. Rutherford, F.R.S., on the "Properties of the Alpha Rays from Radio-active Material." The invitation was accepted. The Chairman then called on Messrs. Leggett and Rowbotham to read their papers on "The Clerical Work of a Sectional Engineer's Office." An animated discussion followed the reading of the paper.

RIFLE CLUB.—The range has been approved by the Military authorities, and rifle practice has started.

SCOTLAND EAST CENTRE.

A paper on "The Quadruplex System" was read by Mr. C. J. Mercer, Sectional Engineer, at a meeting of the Local Branch, held on March 29th, 1911. The ordinary quadruplex was first dealt with, followed by brief descriptions of the various types of extended quadruplex. Duplex balancing, apparatus adjustments, and the localisation of apparatus faults were also considered. The paper was illustrated by a number of lantern-slides, showing the theoretical connections of quadruplex and relayed quadruplex circuits.

The last meeting of the Centre took place on April 19th, when Mr. J. McIntyre read a paper on the "Leading-in Arrangements at the G.P.O., Edinburgh," Mr. Machugh, Superintending Engineer, presiding. Descriptions were given of the external and internal fireproof chambers and of the special cable supports between the two chambers. The method of connecting up and arranging the wires on the main distributing frame was fully dealt with. A convenient and simple arrangement was also described whereby faults could be located at the point where one of the routes passed into railway maintenance.

Before the lecture took place the members visited the G.P.O., where the various points in the lecture were gone into by Mr. McIntyre.

An interesting discussion took place afterwards.

Before closing the meeting Mr. Machugh proposed a special vote of thanks to Mr. Miller for his services as Secretary during the Session. He pointed out that not only had a most successful series of lectures been carried through, but that the membership of the Centre had been brought up to 100 per cent.—a record position—all this involving a considerable amount of work. With the vote Mr. Machugh coupled the name of Mr. Gill for his excellent work as Librarian. After Mr. Miller and Mr. Gill had replied, Mr. Tyson was accorded a vote of thanks for operating the lantern during the lectures.

The Committee for this year is as follows: Mr. F. H. Machugh, Mr. C. Crompton, Mr. G. C. Jefferyes (1st Class Engineers), Mr. John Patrick (2nd Class Engineers), Mr. F. Atkins (Sub-Engineers), Mr. W. Miller (Clerks), Mr. B. J. Gill, Librarian, Mr. W. Miller, Local Secretary.

SOUTH WALES CENTRE.

Mr. H. Cranage read a paper on "Short Submarine Cables across Docks and Rivers" at a meeting of the South Wales Centre held at the South Wales Institute of Engineers on Tuesday, March 14th. A number of interesting points in connection with the laying of short cables and the removal of faults were elucidated by the lecturer, who had specially prepared a number of photographic and diagrammatic lantern-slides. The discussion which ensued was exceptionally interesting.

This being the last meeting of the 1910–11 Session, opportunity was taken to express appreciation of the courtesy and tact of the Chairman, Mr. R. McIlroy, and of the services of the lantern operator, Mr. E. B. Tutton, in the form of very hearty votes of thanks.

Acknowledgment was also made of the indebtedness of the Local Committee to the Council of the South Wales Institute of Engineers for the use of their very handsome and commodious lecture theatre and library in which we have been permitted to hold our meetings during the past Session.

Welcome is extended to Mr. J. Martin, formerly of the Engineer-in-Chief's office and now second Assistant-Superintending Engineer in this District, who has been made joint Vice-chairman of this Centre.

NORTH-EASTERN CENTRE.

On Monday, March 27th, a paper by Mr. J. D. Taylor on "Maintenance and Duties" was given before this Centre. In the unavoidable absence of the author through illness the paper was read by Mr. E. H. Farrand. A vigorous and detailed discussion followed the reading of the paper, which in its subject-matter touched closely the daily duties of the engineer.

Notes were taken of the discussion and passed on to Mr. Taylor, and on May 1st a meeting was held at which the discussion was continued, and Mr. Taylor further amplified his contribution and replied to the questions raised.

Visit to works.—The final item of the programme for the session was reached on May 8th, when a party of the members paid a visit to the works of the British L. M. Ericsson Manufacturing Company at Beeston, Notts. By the courtesy of the Manager, J. Ullett, Esq., the party was conducted around the works and a highly interesting and instructive afternoon was spent in watching the various processes in the manufacture of electrical apparatus.

EASTERN CENTRE.

The fifth meeting of the Session was held at Cambridge on the afternoon of Tuesday, February 28th, 1911, when a paper on "Paper-core Cable Faults, their Localisation and Removal," was read by Mr. A. R. Nichols, who dealt with his subject under the following headings:

(1) Description of faults met with during construction and after completion ;

(2) Methods of localisation under various conditions; and

(3) Remedial measures.

The consideration of the various tests detailed by Mr. Nichols was facilitated by some good diagrams, copies of which were distributed to the members present. Under (3) the process of desiccating was fully described, the paper concluding with a reference to the air-pressure tests employed with potheads.

The final meeting of the Session took place on the afternoon of Tuesday, April 4th, when Mr. A. Evans contributed a paper entitled "General Notes on the Construction of Footpaths and Carriageways."

Mr. Evans traced the various methods employed in the making of roadways from the time of the Romans down to the present day, and compared the suitability of the different types for the new conditions arising out of the rapid growth of mechanically driven vehicles. The general methods of construction of the several kinds of footpaths were also fully explained.

Comparative tables were included showing the first cost, upkeep, and scavenging cost of the various types of carriageways, and tables giving contractors' prices for trenching, and the amounts charged by different road authorities for re-instatement. Copies of these tables were handed to the members.

At each meeting the chair was occupied by Mr. J. F. Lamb, and both papers were well discussed by a good attendance of members.

MIDLAND CENTRE.

AIR-GUN SHOOTING.—The shield, presented by G. W. Hook, Esq., has, under the able captaincy of Mr. A. H. Roberts, passed from last year's holders into the custody of the Estimates and Statistical Sections of the Office.

The transfer was effected at a garden party held on our official lawn. In the unavoidable absence of the Superintending Engineer, J. W. Sullivan, Esq., handed over the trophy to the victors.

TENNIS.—The tournament has begun, and preliminary games have resulted in favour of the acknowledged stronger players. A good deal of interest is being evinced in the duels, and it remains to be seen whether the winners of last year's competition will add to their laurels.

BOWLS.—The competition is now becoming keen, and the efforts to find the correct "ground," "weight," and "bias" are wholesome counteracting influences to the strenuous life which is our ordinary official lot.

SWIMMING.—Efforts are being made to form parties weekly, and considerable enjoyment is obtained by members visiting the local baths.

We regret that several officers have been absent on sick leave for prolonged periods, doubtless due to the strain of our present official life, but we trust that all will quickly be restored to good health, and once again be found in their wonted positions in the office.

NORTHERN DISTRICT.

The Annual Staff Dinner of the Northern District was held at the Continental Restaurant, Newcastle-on-Tyne, on March 28th last under the presidency of the Superintending Engineer (Mr. J. McL. Robb). The event happened to coincide with the visit of the Council of the Institution to Newcastle, and with characteristic northern courtesy the members of the Council were invited, and had extended to them a genuine warmth of welcome which made them feel honoured guests indeed! The musical items were exceptionally well rendered and revealed a wealth of talent of which any office might well be proud, whilst a Scottish dialect-recitation to which the Company were treated would have made even Glasgow demand an encore! The toast of "The Engineering Department" was very ably—not to say humorously—proposed by Mr. Mellersh (Surveyor) and responded to by Mr. A. J. Stubbs in a speech of great interest. Mr. T. B. Johnson proposed the health of "The Guests," and those who know Mr. Johnson need not be told that this part of the programme certainly did not detract from the pleasure or the gaiety of the evening. The applause with which the "points" were received testified alike to the ability and the popularity of the speaker. The toast of the Northern District was given by Mr. H. R. Kempe (THE Kempe, as Mr. Johnson described him!) in a characteristic speech of mingled modesty and wit, and was acknowledged by Mr. Robb. Messrs. T. F. Purves and A. W. Martin added a few remarks on their American experiences, and thus brought to a close a gathering notable for its spirit of real comradeship and good humour.

J. M. C.

CHESS.

ENGINEERING DEPARTMENT CHESS CLUB: SEVENTH ANNUAL SUPPER.

On Tuesday, April 25th, at the Holborn Restaurant, the Engineering Department Chess Club held its seventh annual supper. Nearly ninety people were present. Ladies had again been invited, and the wives and friends of many members were present; also many friends of the Club who have retired from the service. A good programme had been provided, and a very pleasant evening was spent. Major O'Meara kindly presided.

The Chess Club has not been quite so successful as during the previous season, but still retains a position in the first division of the Civil Service and Municipal League. Its membership is fifty, and it is hoped to increase this number considerably next season.

BOOKS RECEIVED.

'Calculations in Telegraphy and Telephony, Ordinary and Honours Grades,' by H. P. Few. S. Rentell & Co., London, W.C. Pp. 96, 2s. net.

This little work, which has been written by Mr. H. P. Few, Engineer-in-Chief's Office, will prove of value to students reading up for examinations in telegraphy and telephony, also to junior members of the Engineering Service who are preparing for Departmental examinations.

The work has been divided into five sections, and this method of arrangement will prove a helpful feature, viz: (*a*) Telegraphy, Ordinary Grade; (*b*) Telephony, Ordinary Grade; (*c*) Telegraphy, Honours Grade; (*d*) Telephony, Honours Grade; (*e*) Miscellaneous Examples.

Fully worked solutions are given of all the questions necessitating numerical answers which have been set by the City and Guilds Institute during the period 1900–1910, as well as a number of miscellaneous examples.

The book deals exclusively with the arithmetic of telegraphy and telephony, and it is welcomed as a useful addition to the literature of these subjects. Mr. Few must be congratulated on the care with which the exercises have been prepared.

'Engineering Mathematics,' by C. P. Steinmetz. 292 pages. (McGraw-Hill Book Co., New York, and Hill Publishing Co., 6, Bouverie Street, E.C. 12*s.*)

Dr. Steinmetz has set out in this book the subject-matter of certain lectures delivered at the Union University to his electrical engineering students.

So far as telegraph and telephone engineers are concerned every day emphasises the desirability of their knowledge of applied mathematics being kept in line with, or even in front of their knowledge of, practice, and a careful study of this book will probably fill up some gaps in their equipment. As stated in the preface, the "work is not intended as a complete course in mathematics but as supplementary to the general knowledge of mathematics which every engineer should possess." In a course of study it is intended to fit in with Dr. Steinmetz's works on electrical theory.

In the first chapter ordinary arithmetical operations are reviewed in a way which brings out with startling clearness their limitations and the conditions necessary for a physical meaning. This is followed by the algebra of the general number or complex quantity introducing j. Subsequent chapters deal with potential series and exponential function, trigonometric series, maxima and minima, methods of approximation, empirical curves, and numerical calculations, with an appended note on the theory of functions. The practical examples have been well chosen, and one of the best features of the book is the way in which the author continually directs the mind of the student to the physical meaning of the mathematical operations. The printing is good and clear—a few printer's errors and omissions have been noted but they are not likely to cause misunderstanding.

'Experimental Electrical Engineering and Manual for Electrical Testing,' by V. Karapetoff. (John Wiley and Son, New York, Chapman and Hall, London. Vol. i, xix + 469 pages, 328 figures, 15*s.*; vol. ii, xiv + 333 pages, 209 figures, 10*s.* 6*d.* The volumes are sold separately.)

Vol. i contains all the elementary and fundamental measurements, and the principal tests on direct and alternating current machinery, the treatment of the subjects being thorough and exhaustive. The last twenty-three pages are devoted to the "Elements of Telephony," and include eighteen very excellent and "up-to-date" diagrams and illustrations.

Vol. ii contains comparatively advanced and special tests, and is largely devoted to heavy electrical engineering. It includes a special study of the induction motor andan excellent chapter on alternating current wave form.

Throughout the style is clear and the illustrations excellent.

The general arrangement of the volumes is such as to allow of what the author calls the "concentric" method of study, in which a bird's-eye view of the subject is taken before going into the details of a single branch.

The idea is excellent from the psychological point of view—the student is brought in contact with the subject three times—each time from a more advanced standpoint.

We shall be surprised if our Librarian does not find this book in considerable demand.

'Whittaker's Electrical Engineer's Pocket Book,' edited by Kenelm Edgcumbe, M.I.E.E., Am. Inst. C.E. (Whittaker and Co., 2, White Hart Street, Paternoster Square, E.C. Third edition, thoroughly revised. 5*s.*)

A large amount of information, which will be of use more especially to lighting and power engineers, has been included in the 600 pages of this compact little volume. It is claimed that "it does not merely give a number of formulæ, rules and data, but a kind of synopsis on each subject brought thoroughly up to date."

The contents are grouped under the following headings:

Useful Numbers, Mathematics and Physics, Practical Mechanics, Electrical Tables, Magnetism, Electricity, Electrical Measuring Instruments, Electric Clocks, Electric Lighting, Secondary Batteries, Heavy-Current Resistances, D.C. Dynamos and Motors, Alternating Current Machines, Testing Generators, Motors and Transformers, Electrical Transmission of Power, Electric Traction, Switches and Switch-gear, Electro-metallurgy and Electro-chemistry, Electric Power Stations and Mains, and Legal Information.

We have examined several sections and found the treatment clear and full.

An extensive and well-arranged index is provided, and everyone knows that by its index such a book stands or falls.

A few trial references revealed the absence of any reference to the Weston Standard cell, and the now well-recognised names for the magnetic circuit units are also missing. These, however, were exceptional cases; as a rule we found what we sought quite readily, and we can recommend the book as a handy guide and companion.

TRADE LISTS.—The India-Rubber, Gutta-Percha, and Telegraph Works Co., Ltd., Silvertown, London, S.E., have just issued two lists—(*a*) Galvanic Batteries and (*b*) Covered Wires, Jointing Tools and Materials, which contain valuable data on these respective subjects. They will be pleased to supply, on application, copies to interested readers.

CORRESPONDENCE.

COMMERCIAL EFFICIENCY.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

SIR,—Efficiency is a term of very wide application, and it is not possible in the space of an article in this JOURNAL to deal with the subject comprehensively. I propose, therefore, to only deal with the more important applications as affecting our profession as engineers in the Post Office.

Broadly speaking, the efficiency of any engineering plant or scheme may be expressed in the following three terms:

(1) Absolute efficiency,
(2) Relative efficiency, and—
(3) Commercial efficiency;

by which is meant (1) the efficiency compared with that theoretically possible; (2) the efficiency compared with that of the best similar plant or machinery known; and (3) the efficiency expressed commercially, *i.e.* its power of producing the best commercial results, this term, which is much the most difficult to expressly determine, is nevertheless the most important; it may be quite independent of (1) and (2), and by his power of foreseeing the best result under this heading the success or failure of an engineer is determined.

I am the more constrained to call special attention to the importance of commercial efficiency because, in a large Government service like our own, there is always a tendency to lay more stress on the absolute and relative efficiencies, whereas in an outside concern which is dependent for its existence on its power of paying dividends, the commercial efficiency is of paramount importance, all other considerations being subordinated to it. Absolute and relative efficiencies are, of course, of extreme importance in all Post Office work which intimately affects the convenience and business of the public generally, and consequently comes in for a very large amount of criticism both from a professional point of view and also from that of the man in the street, who is always supposed to be a most important personage, but who, nevertheless, is, as a rule, only in a position to judge one side of the question, and that is the efficiency of any scheme as concerns himself.

In considering, therefore, any engineering scheme, it is our duty while laying stress on the value of absolute and relative efficiency, yet to endeavour to take a comprehensive view of the whole situation which will be created by the adoption of the proposed scheme, and to assign a degree of importance and efficiency value to each detail of the scheme, such as will produce the best commercial result as a whole. High absolute and relative efficiencies are always expensive, and it is therefore necessary to determine the efficiency which it will pay to adopt.

In former days, when engineering was not the exact science which it now is, the engineer was an engineer by instinct; in designing any machine or scheme he instinctively gave the proper value to each item forming the whole, and it is, I think, this engineering instinct which is now so obviously lacking in many schemes which are nowadays adopted.

Everyone is nowadays necessarily a specialist; the branches of engineering are so multitudinous that it is a physical impossibility for any man to excel in all of them, and the result is a tendency for the specialist to only consider the efficiency of the small piece of the large machine or scheme which he is designing, and to adopt the highest absolute efficiency attainable for that part, without considering the machine or scheme as a whole and adopting an efficiency for his particular portion which will fit together best with the other component items and give the highest commercial efficiency as a whole.

As an example, I might mention the following case with which the writer is acquainted. It was necessary to provide machinery for a certain service, and the machines ultimately selected had an absolute efficiency of 80 per cent., but the particular combination of apparatus and machinery necessary to drive these machines had only an efficiency of 75 per cent., giving a resultant efficiency of 60 per cent.; by installing a cheaper and less efficient machine, having an absolute efficiency of 70 per cent., it would have been possible to employ a combination of apparatus and machinery for driving which has an efficiency of 91 per cent., the resultant efficiency being 63·7 per cent.; the machine of lower absolute efficiency is also very much simpler in construction, lower in capital cost, and cheaper to maintain in every way, with the result that the adoption of the less efficient machine would have resulted in a much higher commercial efficiency for this scheme as a whole than can be obtained with the combination adopted.

Applying this principle more broadly, I have taken one section of our stores vocabulary, and I find that 87 per cent. of the items contained in it are ordinary commercial articles which can be bought over the counter; the Post Office, however, considers it necessary to have detailed specifications for these items, and to have them specially made to these requirements, with the result that the absolute efficiency of the items is very high, but the commercial efficiency is very low owing to the extra cost in making special apparatus, in testing and examining, preparing specifications, etc. The commercial articles satisfy outside engineers, and might in many instances be adopted with advantage by the Post Office.

Numerous applications of the same principle—which is equally applicable to accounting and other schemes—will suggest themselves, but perhaps enough has been said to indicate the danger that is run in attempting to attain to a high degree of absolute efficiency in any one item of a system without taking the whole of the factors forming the complete system sufficiently into consideration, and thus not securing the best commercial result as a whole.

December 9th, 1910. E. H. WALTERS.

OBITUARY.

It is with regret that we have to announce the death of Mr. J. G. Holdsworth, who passed away at his residence at Whalley Range, Manchester, on April 6th.

Mr. Holdsworth joined the Magnetic Telegraph Company in December, 1861, and was transferred to the Post Office in 1870. After many years' service in Newcastle-on-Tyne, first as Inspector and afterwards as Engineer, he was appointed Assistant Superintending Engineer of the North-Western District on May 1st, 1901, and removed to Manchester in the following month. Mr. Holdsworth was superannuated in 1908, and afterwards resided in Manchester—apparently in the enjoyment of good health—until, on April 3rd, he was seized with a paralytic stroke, from which, owing to heart weakness, he never rallied, and death supervened three days later.

Mr. Holdsworth, who did much good work for the Department in the pioneer days, was widely known and greatly respected by a large circle of friends throughout the Post Office Service and in the Masonic Body, of which he was a prominent member. His cheerful presence and ready wit made him a genial companion, and he will be sadly missed by those who knew him best.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT (LONDON).

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	De Lattre, A. L. .	Staff Engr., 1st Cl.	1886; Jr. Clk., Eng'g. Dept.,'91: Clk., 2nd Cl., '97; Tech. Officer, 2nd Cl., '98; Asst. Suptg. Engr., '03; Staff Engr., 1st Cl., '07; Suptg. Engr., '09.
„	Waring, R. .	Asst. Supertg. Engr.	1882; Jr. Clk., Eng'g. Dept., '82; Engr., 1st Cl., '97; Staff Engr., 2nd Cl., '05.
„	Martin, J. . .	„ „	1872; Relay Clk., Eng'g. Dept., '85; Engr., 2nd Cl., '91; Engr., 1st Cl., '99; Staff Engr., 2nd Cl., '05.
„	Twells, W. E. .	Staff Engr., 2nd Cl.	1892; Jr. Clk., Eng'g. Dept., '96; Engr., 2nd Cl., '01; Engr., 1st Cl., '09.
„	Price, J. P. .	Asst. Supertg. Engr.	1885; Sub-Engr., Eng'g. Dept., '96; Engr., 2nd Cl., '98; Engr., 1st Cl., '01.
„	Gillespie, J. T. .	Engr., 1st Class	1888; Sub-Engr., '96; Engr., 2nd Cl., '00.
„	Whibley, E. J. .	Clk., 1st Class, Engr.-in-C.'s Office	1884; Jr. Clk., Eng'g. Dept., '91; 3rd Cl. Clk., '99; 2nd Cl. Clk., '05.
„	Miles, H. A. .	Ditto	1879; 3rd Cl. Clk., '98; 2nd Cl. Clk., '03.
„	Few, H. P. .	Clk., 2nd Class, Engr.-in-C.'s Office	C. C. & T., L. P. S., '93; 3rd Cl. Clk., '02.
„	Young, A. . .	Ditto	Asst. Clk., Eng'g. Dept., '98; 2nd Cl. Examiner, T. S. D., '99; 3rd Cl. Clk., E.-in-C.O., '03.
„	Gold, R. J. S. .	„	Asst. Clk., S. B. D., '98; 2nd Cl. Examiner, T. S. D., '00; 3rd Cl. Clk., E.-in-C.O., '03.
„	Thorne, A. E. .	„	2nd Cl. Examiner, Stores Dept., '99; 3rd Cl. Clk., E.-in-C.O., '03.
„	Gillett, B. F. .	Clk., 2nd Class, Supertg. Engr.'s Office	1887; Jr. Clk., Eng'g. Dept., '99.
„	Allin, J. T. A. .	Ditto	1890; Jr. Clk., Eng'g. Dept., '99.
„	Blyth, W. B. .	Second Navigating Officer, "Monarch"	3rd Navg. Officer, "Monarch," '02; 2nd Navg. Officer, "Alert," '06.
„	Flavel, G. H. .	2nd Navigating Officer, "Alert"	3rd Navg. Officer, "Monarch," '09.
„	Corton, S. G. .	3rd Navigating Officer, "Monarch"	4th Navg. Officer, "Monarch," '09.
„	Duncan, R. .	3rd Engineer, "Monarch"	4th Engr., "Monarch," '06.

RETIREMENTS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Stockwell, T. H.	Staff Engr., 1st Cl.	1870; Staff Engr., 1st Cl., '95.
,,	Constable, A. W.	Clk., 3rd Cl., Suptg. Engr.'s Office.	2nd Cl. Telegraphist, '85; 2nd Cl. Jr. Clk., '95; 1st Cl. Jr. Clk., '96 (Nov., 3rd Cl. Clk.).

TRANSFERS.

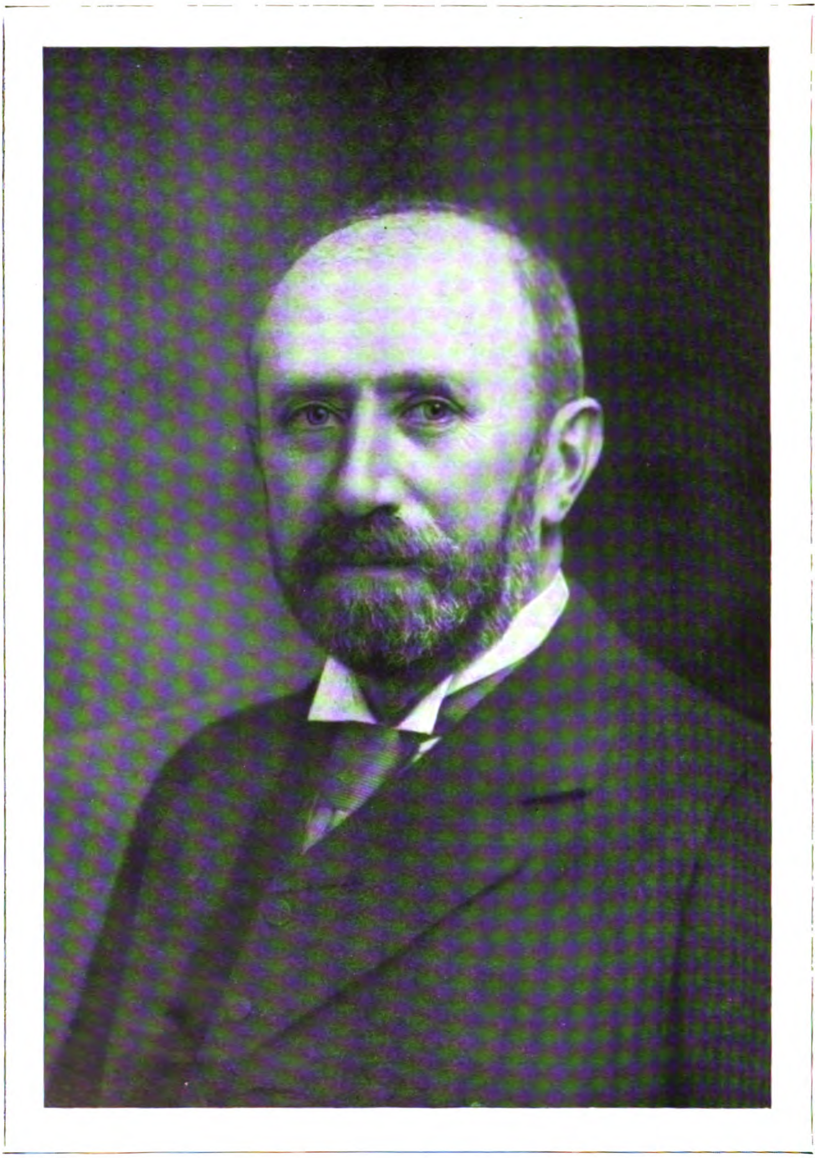
Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Tandy, F.	Asst. Supt. Engr.	Met. C.	Suptg. Engr.	S.E.	1 : 5 : 11
Elliott, J. R. M.	Ditto	Met. N.	Asst. Suptg. Engr.	Met. C.	1 : 5 : 11
Bathurst, N.	1st Cl. Engr.	,,	Engr., 1st Cl.	,,	1 : 5 : 11
Lewis, T.	Ditto	,,	,,	,,	1 : 5 : 11
Price, H. C.	,,	,,	,,	Met. S.	1 : 5 : 11
Brown, J.	2nd Cl. Engr.	,,	Engr., 3rd. Cl.	Met. C.	1 : 5 : 11
Dolton, W.	Ditto	,,	,,	,,	1 : 5 : 11
Hartnell, C. H. B.	,,	,,	,,	,,	1 : 5 : 11
McClarence, F.	,,	,,	,,	Met. S.	1 : 5 : 11
Pink, E. A.	,,	,,	,,	,,	1 : 5 : 11
Wood, A. H.	,,	,,	,,	,,	1 : 5 : 11
Jones, T. V.	Sub-Engr.	,,	Sub. Engr.	Met. C.	1 : 5 : 11
Neal, W. A.	,,	,,	,,	Met. S.	1 : 5 : 11
Schofield, G. H.	,,	,,	,,	,,	1 : 5 : 11
Downing, G. H.	1st Cl. Clk.	,,	1st Cl. Clk.	S.E.	10 : 4 : 11
Allin, J. T.	2nd Cl. Clk.	Met. S.	2nd Cl. Clk.	,,	1 : 5 : 11
Gillett, B. F.	,,	,,	,,	,,	1 : 5 : 11
Kirby, J. W.	,,	Met. N.	,,	Met. S.	1 : 5 : 11
Timson, J. R.	,,	E.L.	,,	,,	1 : 5 : 11
Parish, G. J.	,,	Met. N.	3rd. Cl. Clk.	E.L. & P.	1 : 5 : 11
Adams, W. F.	3rd Cl. Clk.	,,	,,	Met. C.	1 : 5 : 11
Coles, W. C.	,,	,,	,,	,,	1 : 5 : 11
Gerke, J. J.	,,	,,	,,	,,	1 : 5 : 11
Gould, V. R.	,,	,,	,,	,,	1 : 5 : 11
Griffiths, E. F.	,,	,,	,,	,,	1 : 5 : 11
Jackson, R.	,,	,,	,,	,,	1 : 5 : 11
Larner, E. T.	,,	,,	,,	,,	1 : 5 : 11
Lines, E. R.	,,	,,	,,	,,	1 : 5 : 11
Petchey, F. G.	,,	,,	,,	,,	1 : 5 : 11
Salter, E. J.	,,	,,	,,	,,	1 : 5 : 11
Smith, H. S.	,,	,,	,,	,,	1 : 5 : 11
Spears, A. E.	,,	,,	,,	,,	1 : 5 : 11
Brown, W. G.	,,	,,	,,	Met. S.	1 : 5 : 11
Delaney, W. J.	,,	,,	,,	,,	1 : 5 : 11
Doe, G. D.	,,	,,	,,	,,	1 : 5 : 11
Chubbock, J. H.	,,	Met. C.	,,	,,	1 : 5 : 11
Coulson, F. J.	,,	Met. N.	,,	,,	1 : 5 : 11
Francis, H. J. B.	,,	Met. C.	,,	,,	1 : 5 : 11
Joseph, J. W.	,,	,,	,,	,,	1 : 5 : 11
Macrae, D. L.	,,	,,	,,	,,	1 : 5 : 11
McNally, W. J.	,,	Met. N.	,,	,,	1 : 5 : 11
Himes, S.	,,	,,	,,	,,	1 : 5 : 11
Morgan, G. H.	,,	,,	,,	,,	1 : 5 : 11

TRANSFERS—*continued.*

Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Owen, W. G.	3rd Cl. Clk.	Met. N.	3rd Cl. Clk.	Met. S.	1 : 5 : 11
Portch, A. J.	,,	,,	,,	,,	1 : 5 : 11
Riley, R.	,,	,,	,,	,,	1 : 5 : 11
Symonds, T. H.	,,	,,	,,	,,	1 : 5 : 11
Dodgson, P. J.	,,	Met. C.	,,	S.E.	1 : 5 : 11
Nevill, A. J.	,,	,,	,,	,,	1 : 5 : 11
Senhenn, H. W.	,,	,,	,,	,,	1 : 5 : 11
Simpson, W. H.	,,	,,	,,	,,	1 : 5 : 11
Colman, W. A.	,,	Met. N.	,,	,,	1 : 5 : 11
Dunn, F. G.	,,	,,	,,	,,	1 : 5 : 11
Brown, H.	,,	Met. S.	,,	,,	1 : 5 : 11
Camp, A. W. K.	,,	Met. N.	,,	Met. C.	1 : 5 : 11
Cousins, C.	,,	,,	,,	,,	1 : 5 : 11
Frost, M. P.	,,	,,	,,	,,	1 : 5 : 11
Glendinning, W.	,,	,,	,,	,,	1 : 5 : 11
Masaroon, R. G.	Asst. Supt. Engr.	Ire. N.	Asst. Suptg. Engr.	N. Wa.	27 : 3 : 11
Martin, J.	2nd Cl. Staff Engr.	E. in C.O.	do.	S. Wa.	26 : 3 : 11
Waring, R.	Ditto	,,	,,	Met. C.	8 : 4 : 11
Bullock, A. H.	1st Cl. Engr.	Ire. N.	1st Cl. Engr.	M. (sub.)	27 : 3 : 11
Moon, W.	Ditto	Met. N.	,,	N.W.	1 : 4 : 11
Alexander, R.	2nd Cl. Engr.	E. in C.O.	,,	Sc. E.	17 : 2 : 11
Baxter, J.	Ditto	,,	,,	Inventory Staff	6 : 3 : 11
Gillespie, J. T.	,,	,,	,,	S. W.	27 : 3 : 11
Bradfield, R.	,,	Ire. N.	2nd Cl. Engr.	,,	1 : 5 : 11
Chittick, H. S.	,,	S.W.	,,	E. in C.O.	12 : 3 : 11
Eason, A. B.	,,	N.	,,	,,	19 : 3 : 11
Gardner, A. W.	,,	Met. N.	,,	,,	1 : 5 : 11
Grace, H.	,,	N. Wa.	,,	Sc. E.	5 : 3 : 11
Halton, R.	,,	E. in C.O.	,,	M.	22 : 5 : 11
Hannam-Clark, H. C.	,,	,,	,,	S. E.	1 : 5 : 11
Hansford, R. V.	,,	,,	,,	Sc. E.	1 : 5 : 11
Marris, G. C.	,,	,,	,,	N. Wa.	1 : 5 : 11
Monaghan, T. J.	,,	,,	,,	Ire. N.	1 : 5 : 11
Murphy, F.	,,	,,	,,	Met. S.	1 : 5 : 11
Ogden, E.	,,	N.W.	,,	S. Wa.	12 : 3 : 11
O'Neill, J. W.	,,	E. in C.O.	,,	Ire. S.	1 : 5 : 11
Ward, W. G.	,,	,,	,,	N.	1 : 5 : 11
Anderson, J.	Sub-Engr.	Sc.W.	,,	E. in C.O.	21 : 3 : 11
Wootton, G. A. H.	,,	E.L.	Sub-Engr.	,,	14 : 5 : 11
Cunningham, J. H.	3rd Cl. Clk.	Sc.W.	3rd Cl. Clk.	Sc. E.	2 : 4 : 11

COMMUNICATIONS.

All Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.



Sir Alec F. King, K.C.B.

THE
Post Office Electrical Engineers' Journal

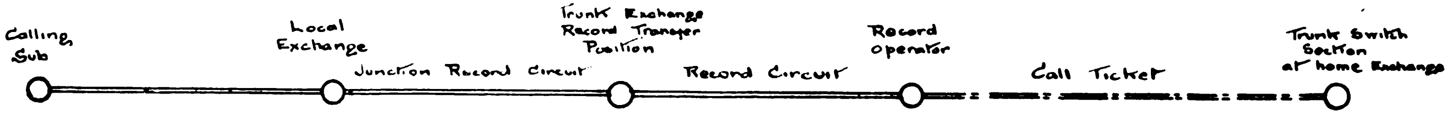
PNEUMATIC DISTRIBUTION OF TRUNK CALL TICKETS IN THE LONDON TRUNK EXCHANGE.

By H. P. Brown.

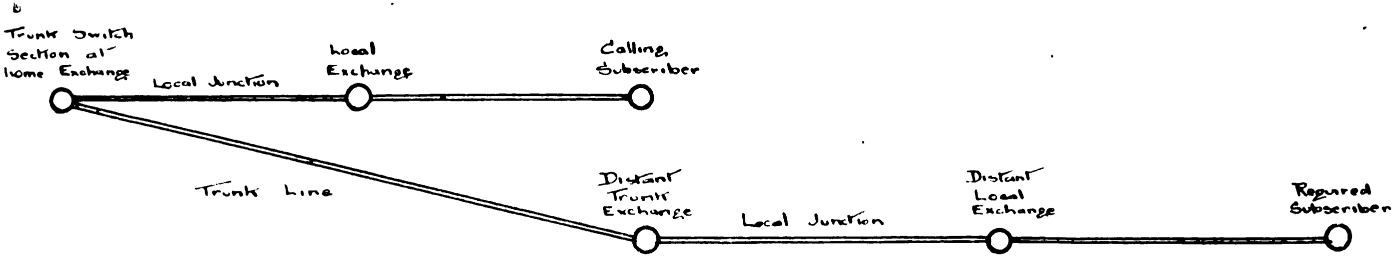
Before entering into a description of the equipment needed for distributing tickets in a large Trunk exchange, it is perhaps desirable that a brief reference should be made to the procedure followed in such an exchange in the handling of the long-distance traffic.

A subscriber who wishes to effect a Trunk connection calls his local exchange and asks for "Trunks." His line is then connected by the local operator to a signalling junction circuit, known as a record circuit, which terminates on a jack with signalling apparatus on a record transfer section at the Trunk exchange. On this section are a number of plugs, each forming one termination of a circuit, whose other end connects to a record operator's telephone set. On receipt of a calling signal at the transfer position, one of these plugs is inserted in the relevant jack, and the calling signal is by this means transferred to the record operator. The latter turns a speaking key which simultaneously extinguishes the calling glow and places her telephone in circuit with the subscriber. Particulars of the Trunk connection required are then obtained and written on a Trunk call ticket, and the subscriber is informed that he will be called when his connection matures. The restoration of the record operator's speaking key gives a clearing signal and causes the lines to be disconnected, The call ticket then circulates to the section on which the required Trunk line terminates, and in turn with other calls arrangements are made between the home and distant exchanges for completing

PNEUMATICS DISTRIBUTION OF TRUNK CALL TICKETS.

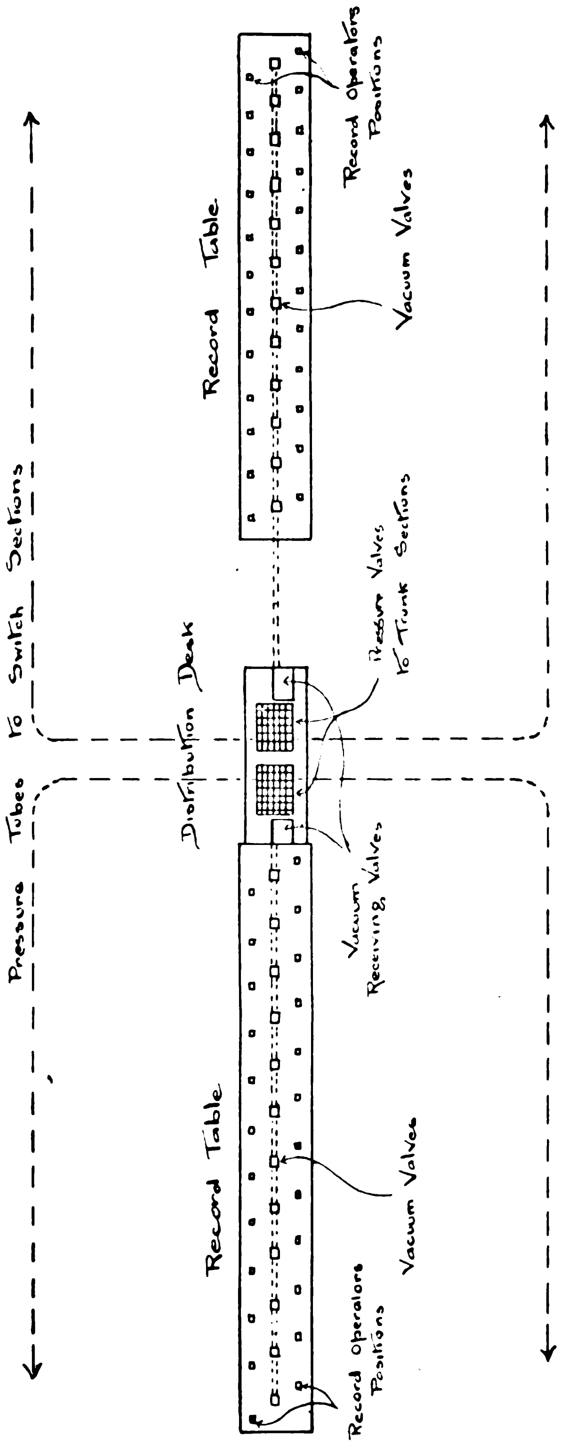


Passing the particulars from the calling subscriber to the point where the call ticket reaches the relevant trunk switch section at the home exchange.



Completing the required connection from the trunk section after the call ticket has been delivered at that point.

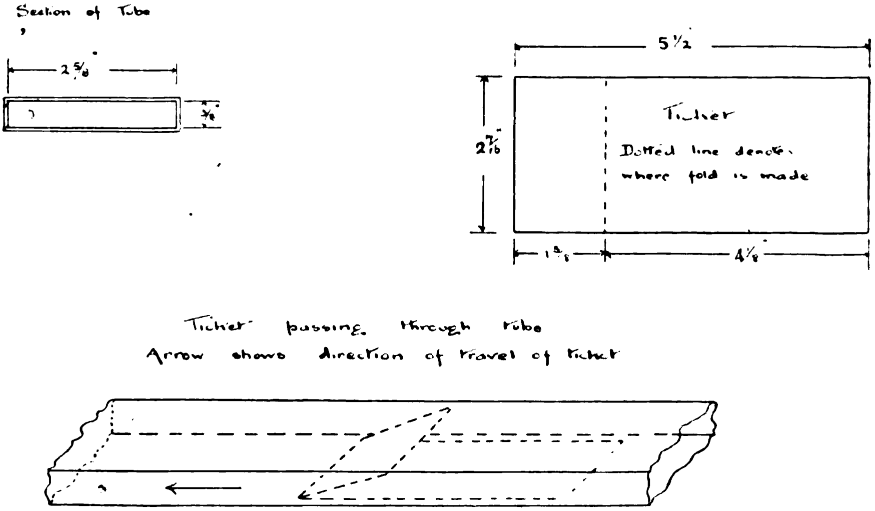
I.—Diagram Illustrating the Procedure followed in Effecting a Trunk Connection.


Pressure Tubes to Switch Sections
Record Table
Record Operators Positions
Vacuum Valves
Distribution Desk
Pressure Valves to Trunk Sections
Vacuum Receiving Valves
Record Table
Vacuum Valves
Record Operators Positions

2.—Diagram Illustrating Lay-out of Record Tables and Distribution Desk.

the connection. On the call ticket are recorded the subscribers' numbers at the home and distant exchanges, the time of making the connection, the duration of the conversation, and other minor particulars. On completion of a Trunk conversation the ticket is retained at the Trunk section for some time, as long as two or three hours in certain exchanges, the object being to facilitate the answering of inquiries concerning any particular call which has been passed. The circulation of a call, as outlined above, is shown in diagrammatic form in **1**.

Formerly the call tickets were conveyed from the record operators to a central distribution point by band carriers, and from the latter point they were distributed by hand to the Trunk sections. This involved delay which it was desired to eliminate.


Section of Tube
2 5/8"
3/8"
5 1/2
2 7/16"
Ticket
Dotted line denotes where fold is made
1 3/8
4 1/8
Ticket passing through tube
Arrow shows direction of travel of ticket

3.—PNEUMATIC TUBE AND TICKET WITH DIMENSIONS.

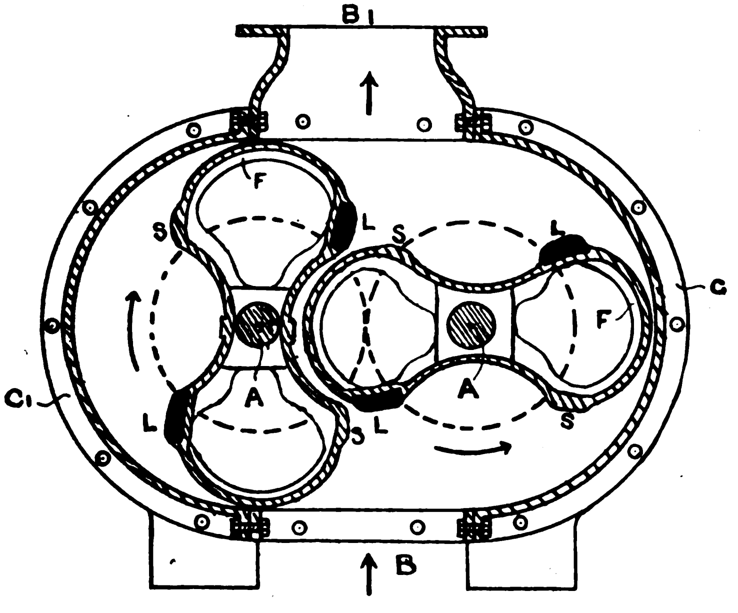
The pneumatic distribution system, recently installed in the London Trunk exchange, provides for the transference of tickets from all the record operators by vacuum tube to a central distribution desk, and from this point to any one of the Trunk sections by pressure tube.

The record operators sit along the sides of two long tables, each of which is provided with twelve vacuum valves centrally situated, so that one valve is available for the use of two operators on opposite sides of the table. Each table is provided with only one tube, which is common to the twelve vacuum valves.

The distribution desk is situated between the two record tables, and on each end terminates the vacuum tube from the corresponding record table. The central portion of the distribution desk is occupied by the pressure valves which operate the tubes to the trunk sections. The arrangement is illustrated in outline in **2**.

The tubes used in this system are rectangular in section ($2\frac{5}{8}$ in. by $\frac{3}{8}$ in.), and the tickets have a width slightly less than that of the tube. By folding over one end, as illustrated in **3**, the ticket is conveyed through the tube by the air-pressure acting against the flap so formed. The use of carriers, so essential in all other forms of pneumatic tube systems, is thus dispensed with.

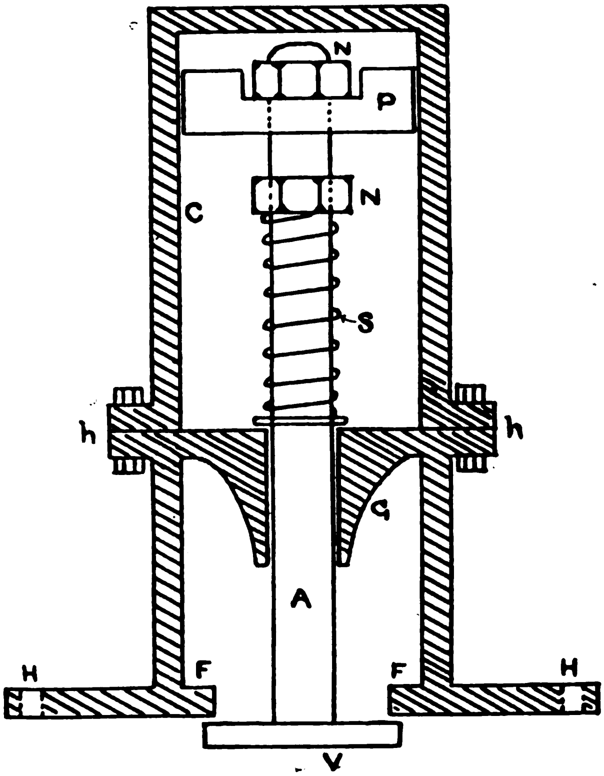
The air-pressure and vacuum required for operating the system are derived from a Root's blower driven by a 3½ h.p. motor through belt gearing. The motor runs at 750 to 1000 revolutions per minute, the ratio of the pulleys is 1 : 4·25, and the speed of the blower is consequently 176 to 235 revolutions per minute. The output of the blower at a speed of 190 revolutions per minute is sufficient to maintain a manometer reading of 600 mm. of water, or about 14 oz. pressure per square inch, and a vacuum of 800 mm. of water, or about 18 oz. per square inch, during the busiest part of the day, the total consumption of electrical energy under these conditions being equivalent to 2·6 h.p.



4.—Cross Section through Case and Flies of Blower.

It may not be considered out of place to give a brief description of the construction of the blower, for although there are many similar blowers in use for smiths' forges, etc., their adoption for pneumatic tube work does not appear to have been very extensive, certainly not in the Post Office. **4** illustrates in diagrammatic form a section across the case and flies of the blower. The case CC consists of a casting in three main portions bolted together on machine-flanged joints. The two semi-cylindrical halves are carefully machined to provide true and closely fitting surfaces for the flies F, which revolve inside them. The end pieces of the case are also accurately machined to provide a closely fitting cover over the ends of the revolving flies.

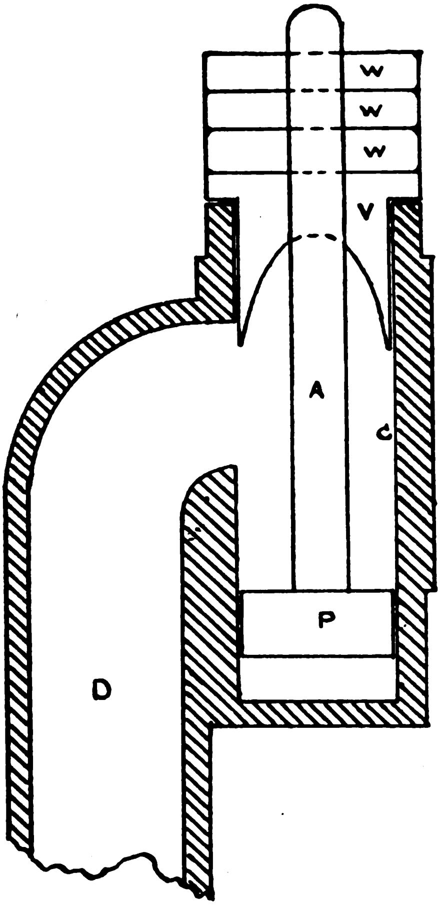
The two flies are castings shaped like the figure 8 as shown in the sketch. The fly-spindles AA are geared at one end so that they revolve in opposite directions. Two portions, S.S.S.S., of each fly are carefully machined, and two corresponding portions on the reverse side of each, L.L.L.L., are provided with a strip of hard elastic felt. As the flies revolve the machined surface on one fly bears against a felt surface on the other continuously, effectually preventing the passage of air between the flies. The air is drawn from the intake B by first one fly and then the other, and as each fly revolves the enclosed air in the space between the ends of the fly and the outer case is expelled through the discharge B_1. It is obvious that for efficient



5.—Cross Sectional View of Valve fitted to Intake Pipe.

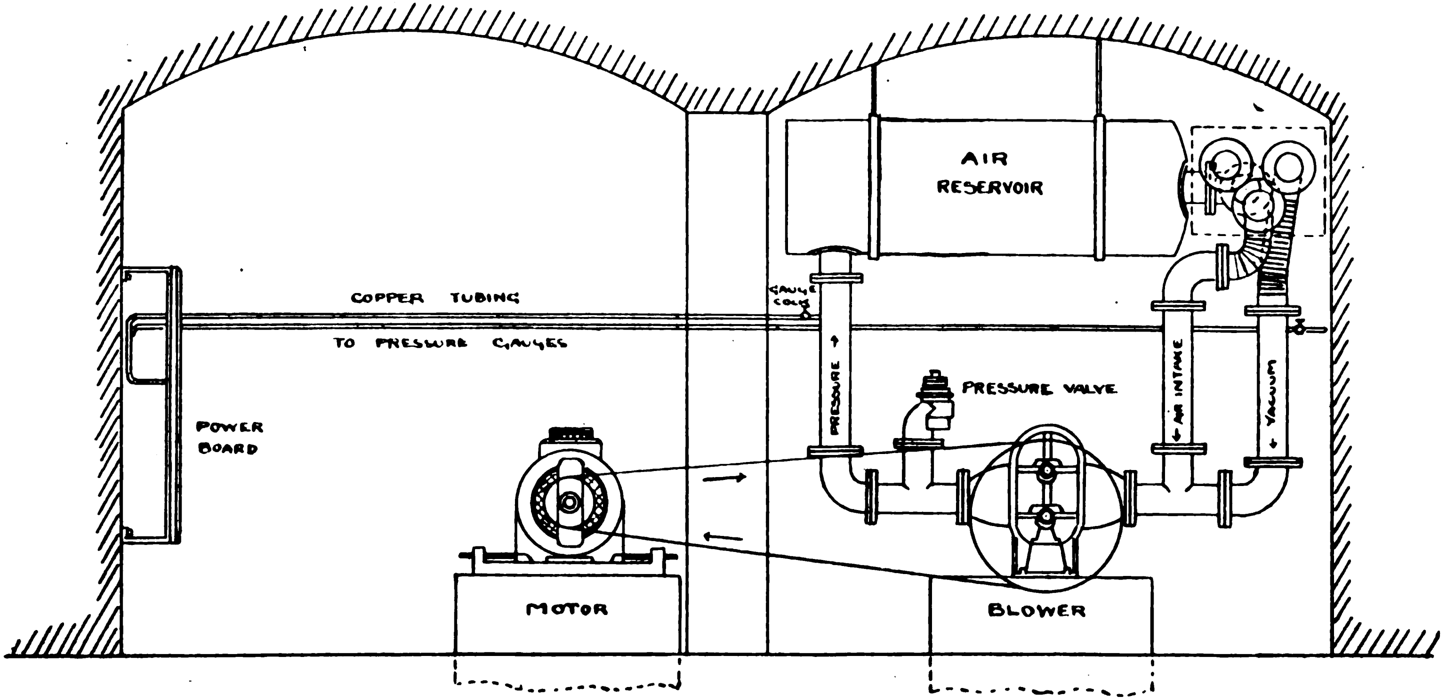
working the whole of the internal faces and revolving parts must fit together most accurately.

On the intake side of the blower a dashpot valve regulated by a spiral spring shown in section in 5 is provided to control the air supply to the blower, and thus control the vacuum on the whole system. The piston P fits accurately the machined air-tight cylinder C



6.—Cross-Sectional View of Valve fitted to Discharge Pipe.

and is kept in position by the spiral spring S, the tension on which is adjusted by the nuts NN. The rod A of the piston passes through the guide G, and on its end is fixed the valve V bearing normally on the faced surface FF of the casting. The flanges HH provide a means for bolting the valve to the end of the intake pipe. The portion of the casting between HH and *hh* has inlets for the air, which, on the release of the valve from its seating, passes into the intake pipe. The piston working in the air-tight cylinder ensures

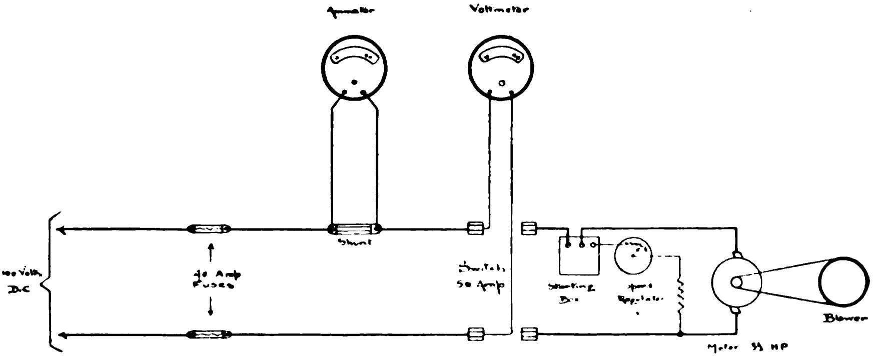


7.—Elevation Showing Lay-out of Blower Equipment in Vaults.

the maintenance of a steady vacuum, preventing any tendency to sudden variations in the vacuum on the whole system.

On the discharge pipe a pressure valve is fitted to ensure a steady delivery of air, and prevent excessive pressures.

6 illustrates this valve in cross section. P is a piston tightly fitting the machined air-tight cylinder C. The rod A connects the piston to the valve V, which is provided with suitable guide pieces, as illustrated, and normally rests on the machined surface of the cylinder extension. Above the valve is an extension of the rod A, and circular weights WWW with central holes are threaded over the extension to rest on the upper portion of the valve. When the pressure reaches a predetermined value, the value and weights rise and allow the air to escape. The piston working in the air-tight cylinder ensures a steady operation of the valve.



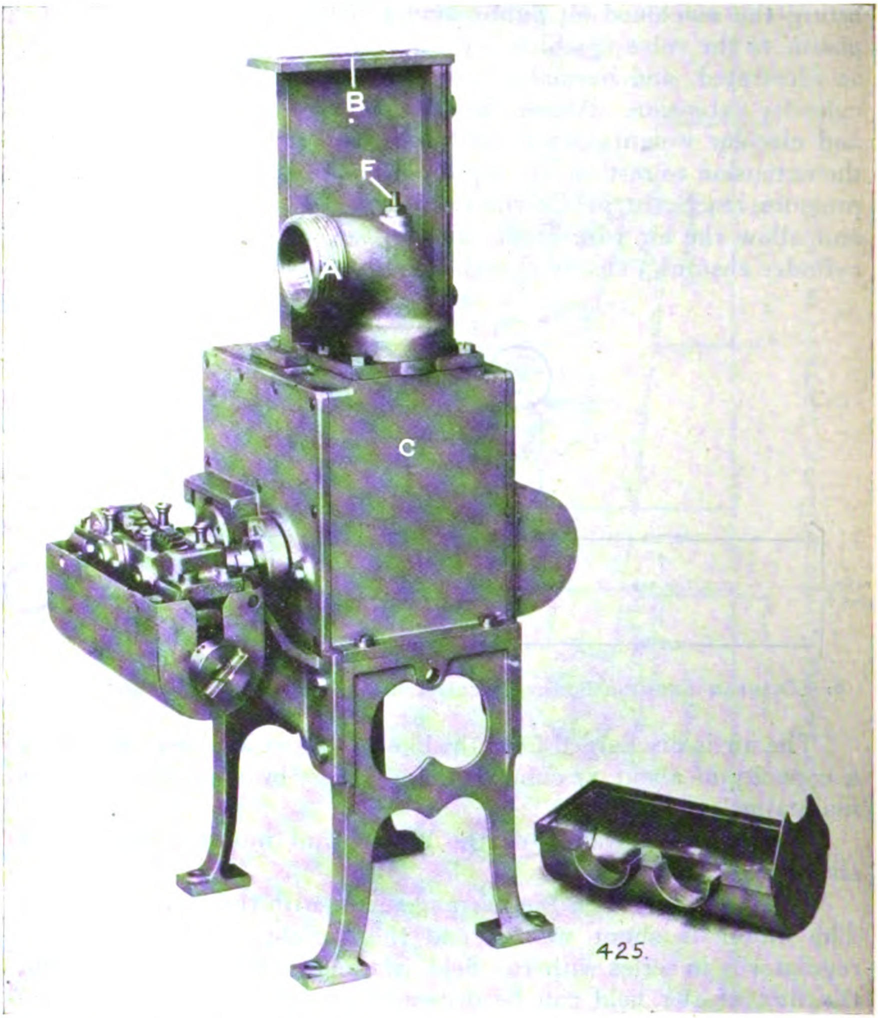
8.—DIAGRAM SHOWING POWER CIRCUIT CONNECTIONS ON BLOWER EQUIPMENT.

The air is discharged from the blower into an air reservoir having a capacity of about 17 cubic feet, and a very even pressure is thus maintained.

A sketch in elevation of the blower and motor equipment is shown in **7**.

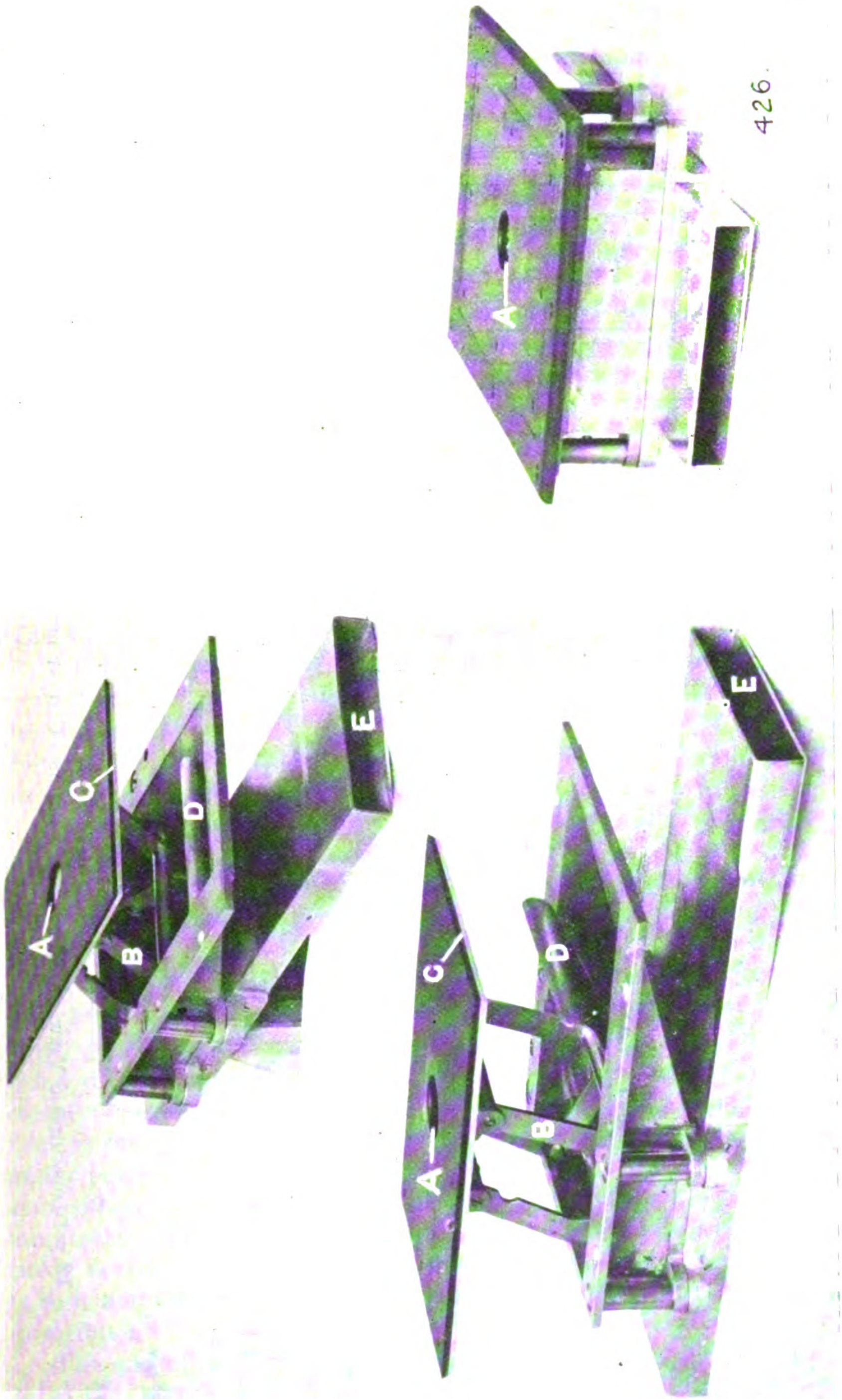
8 shows the power circuit arrangements with the speed regulator. The motor is shunt wound, and the variable resistance of the regulator is in series with the field windings. By this arrangement the flux of the field can be decreased or increased with a corresponding acceleration or reduction in the speed of the motor.

The blower equipment is installed in a vault, but the intake pipe terminates in a dashpot valve in the test room, the object of this arrangement being to secure a supply of air comparatively free from moisture under all weather conditions. The connection between the reservoir and the pressure and vacuum mains is made by means of flexible metallic hose, which effectively prevents the transmission of mechanical vibrations from the blower to the tube system in the switch room. The vacuum and pressure mains, which are of 6 in. cast-iron pipe, run up the face of the building to the switch room on the third floor and are encased in magnesia, which is protected from the weather by an outer covering of galvanised iron. The magnesia minimises temperature variations in the mains, and the condensation of moisture, which might cause defective working in very cold weather, is thus prevented.

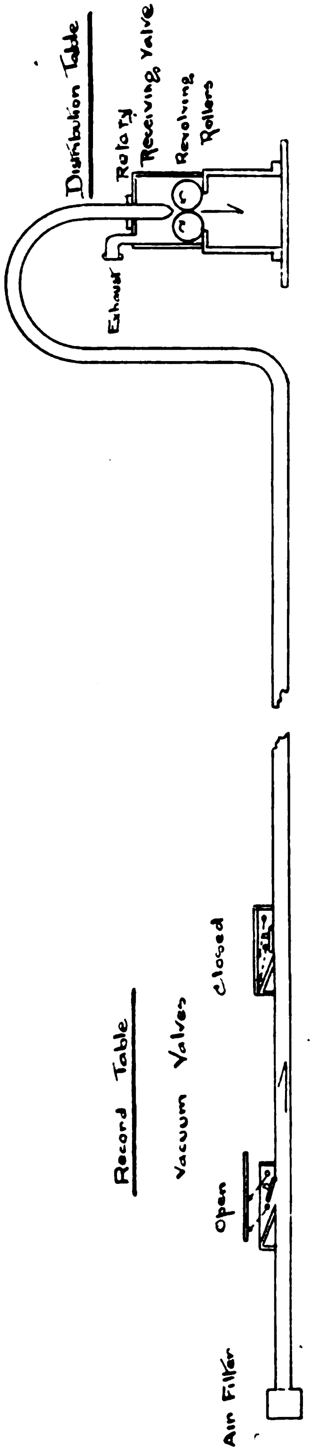


9.—Pneumatic Ticket Distribution. Rotary Receiving Valve.

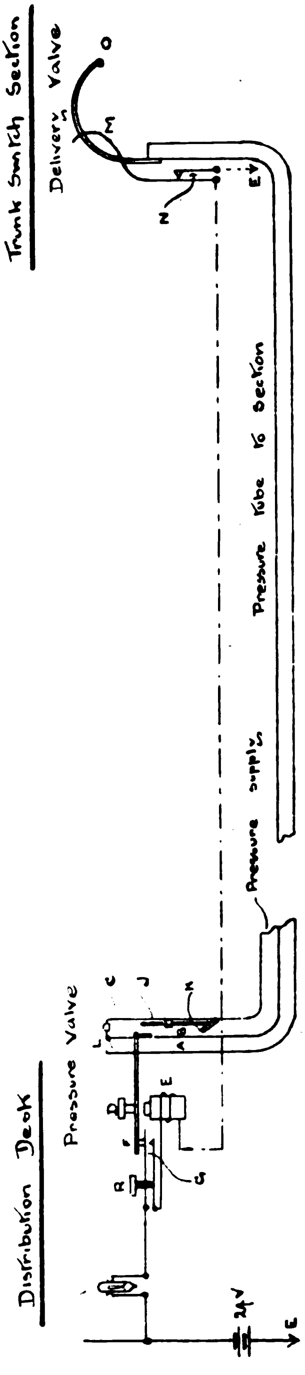
The pressure and vacuum sides of the blower are fitted with gauges, each being provided with an electrical alarm, which is brought into operation by the indicating pointers passing beyond



10.—Pneumatic Ticket Distribution. Vacuum Despatching Valve.



11.—Diagrammatic View of Vacuum Tube and Vacuum Receiving Valve.



12.—Diagrammatic View of Tube and Signalling Circuit between Distribution Desk and Trunk Section.

two fixed limits. An intimation is in this manner given to the test-room attendant, enabling him to re-adjust the speed of the motor, and consequently the pressure and vacuum supply, before any inconvenience in the operation of the tubes is felt.

The vacuum main terminates under the distribution desk, and two connections are made, one to each of the vacuum receiving valves associated with the vacuum tube serving the record table. The receiving valve, illustrated in **9**, provides an automatic delivery of the tickets from the vacuum tubes without any appreciable loss of vacuum in its operation.

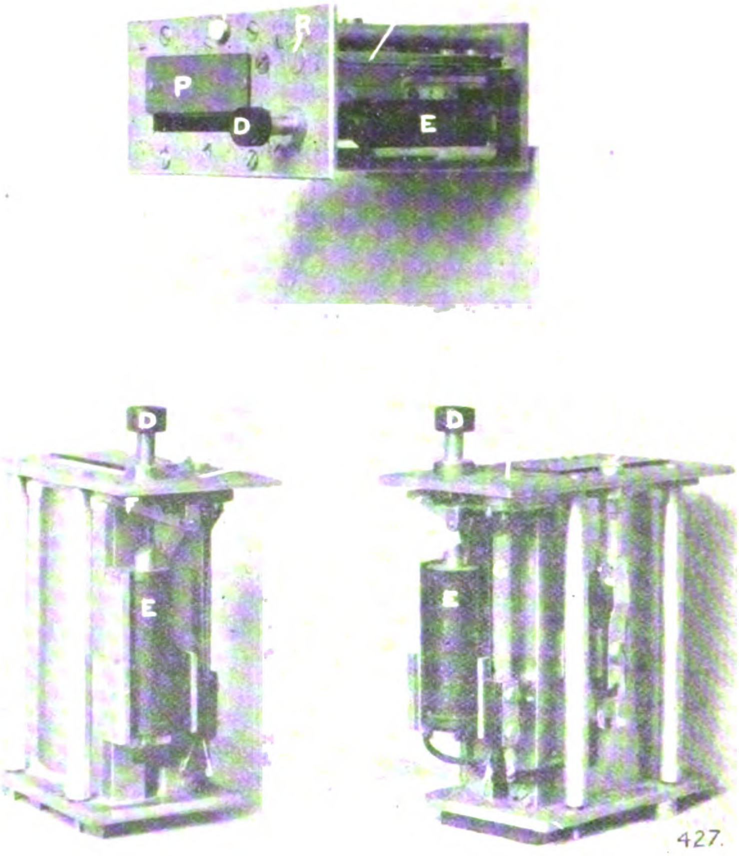
The connection to the vacuum main is made at A, the vacuum tube connects at B, and the tickets placed in the vacuum tube valves on the record table are consequently delivered into the enclosed chamber C. This chamber is shut off from the atmosphere by two highly burnished steel rollers, kept in close contact by four springs pressing against the extremities of the axle bearings. The rollers are made to revolve in opposite directions through the medium of a worm gear driven by a $\frac{1}{10}$ h.p. motor running at 1200 revolutions per minute, the speed of the rollers being about 105 to 115 revolutions per minute. The ends of the rollers are shown at D, and the gear, with which the worm of the motor shaft engages, at E.

When a ticket arrives in the chamber C it is instantly caught between the rollers and delivered into an open compartment beneath the valve, as shown in **11**. The rollers separate, sufficient to allow the passage of the ticket, and are again instantly closed by the pressure of the axle springs.

A plunger valve shown at F (**9**) is provided for the local adjustment of the vacuum.

As previously mentioned, one tube serves a complete record table with twelve vacuum valves, the connection to the tube being made at each point, as shown in **10**. This illustration also shows the construction of the valve, and **11** illustrates in diagrammatic form the complete vacuum tube, valves and rotary receiving valve. The upper portion of the vacuum valve is faced with ebonite, and is provided with a finger hole, "A" (**10**), by which means the valve is readily opened for the insertion of a ticket. A lever adjustment, "B," is provided between the upper cover "C" of the valve, and the under portion "D," which is effective in closing the tube from the atmosphere. In this way the placing of the tickets in the tube is facilitated, the size of the opening necessary for the insertion of the ticket is reduced to a minimum, and the period during which the tube is actually open to the atmosphere is of the shortest possible duration.

The end of each vacuum tube terminates in a small rectangular brass box, the further end of which is fitted with a wire grid and the top with an air-tight sliding cover. The box is filled with cotton-wool, and acts as a filter chamber, preventing the entrance to the tube of particles of dust.



13.—Pneumatic Ticket Distribution. Pressure Despatching Valve.

As the vacuum tubes are entirely automatic no signalling devices are necessary.

The pressure main, which passes up the face of the building, side by side with the vacuum main, also terminates under the distribution desk. It is connected to a series of rectangular compartments, each one running the full length of the desk and providing a common supply to a row of fourteen tubes which are fed from it.

At the same point terminates a tube from each of the Trunk switch sections, one tube serving two operators' positions.

The pressure valve which serves as a connection between the common pressure-supply and an individual tube is shown in **12** and **13**. The valve is divided into two portions, A and B, a small gate C resting on an air-tight seating providing the only passage for air between the two. The gate is opened by a depression of the plunger D, and the axle on which the gate turns is prevented from returning to normal by the operation of the electro-magnet E, whose armature F is rigidly fixed to the gate axle. The depression of the plunger D also closes the spring contacts G, and completes an electrical circuit through the coil of the electro-magnet and a contact on the delivery valve fitted on the switch section. The closing of this circuit gives a glow on the lamp H associated with the pressure valve. The air-pressure on the individual tubes is regulated by the screw J, which opens and closes the flap K extending across the pressure-supply side of the valve. This regulation is necessary in consequence of the varying lengths of the tubes terminating on the desk. Immediately the plunger is depressed the pressure enters the tube and forces up the small vane L, which closes the entrance to the tube against the atmosphere.

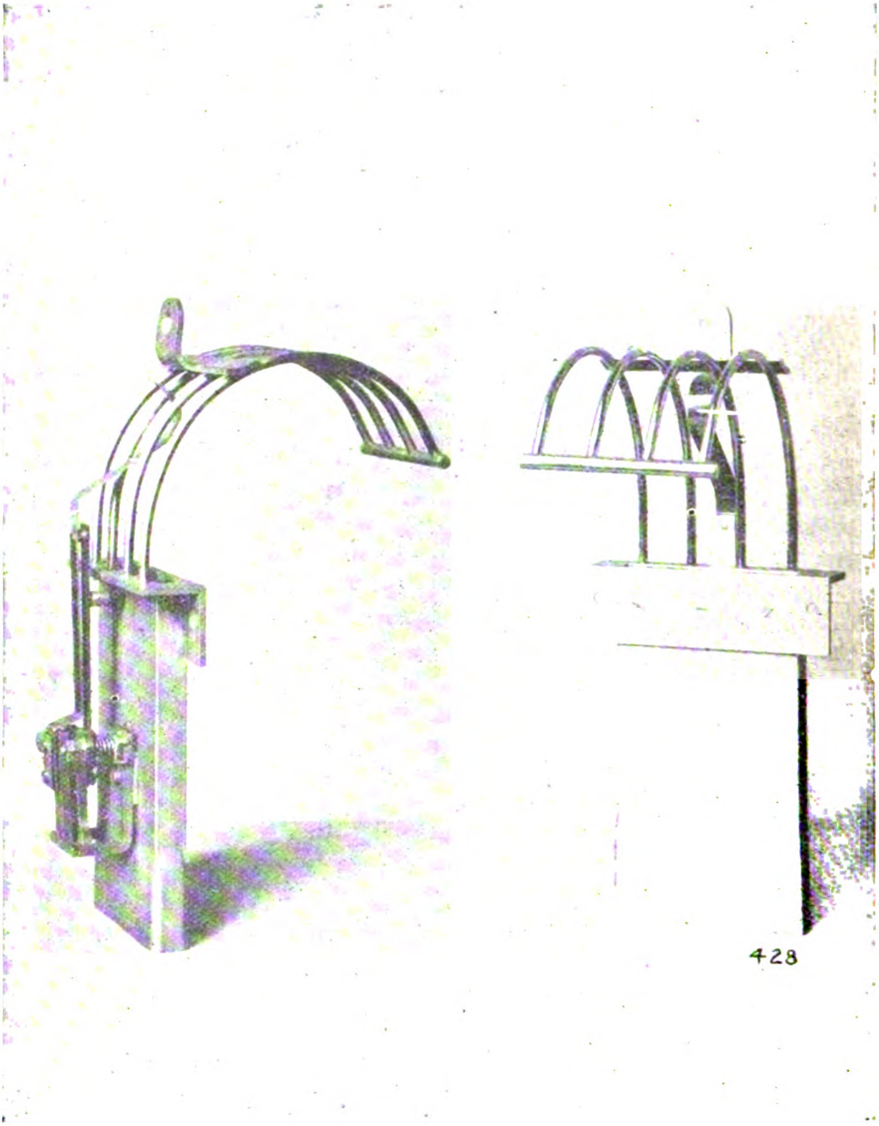
The ticket with folded end is dropped into the tube before the plunger is depressed, and as the vane L closes instantly on the operation of the plunger there is no loss of pressure with the inevitable hissing so objectionable in most pneumatic systems.

The ticket passes through the tube, and during its transit the lamp remains aglow, to be extinguished only after the ticket has reached its destination. A release plunger R is provided to re-set the pressure valve and extinguish the glow should this be necessary when adjustments are being made.

The delivery valve on the switch section is a simple device serving only to deflect the ticket on to the keyboard of the section and to break the electrical circuit which causes the release of the electro-magnet on the pressure valve. The release of the latter extinguishes the lamp and cuts off the pressure from the tube. The delivery valve is shown in **12** and **14**. The ticket emerging from the valve strikes the long lever M, which momentarily breaks the contact N, and is then deflected on to the keyboard by the curved extension O.

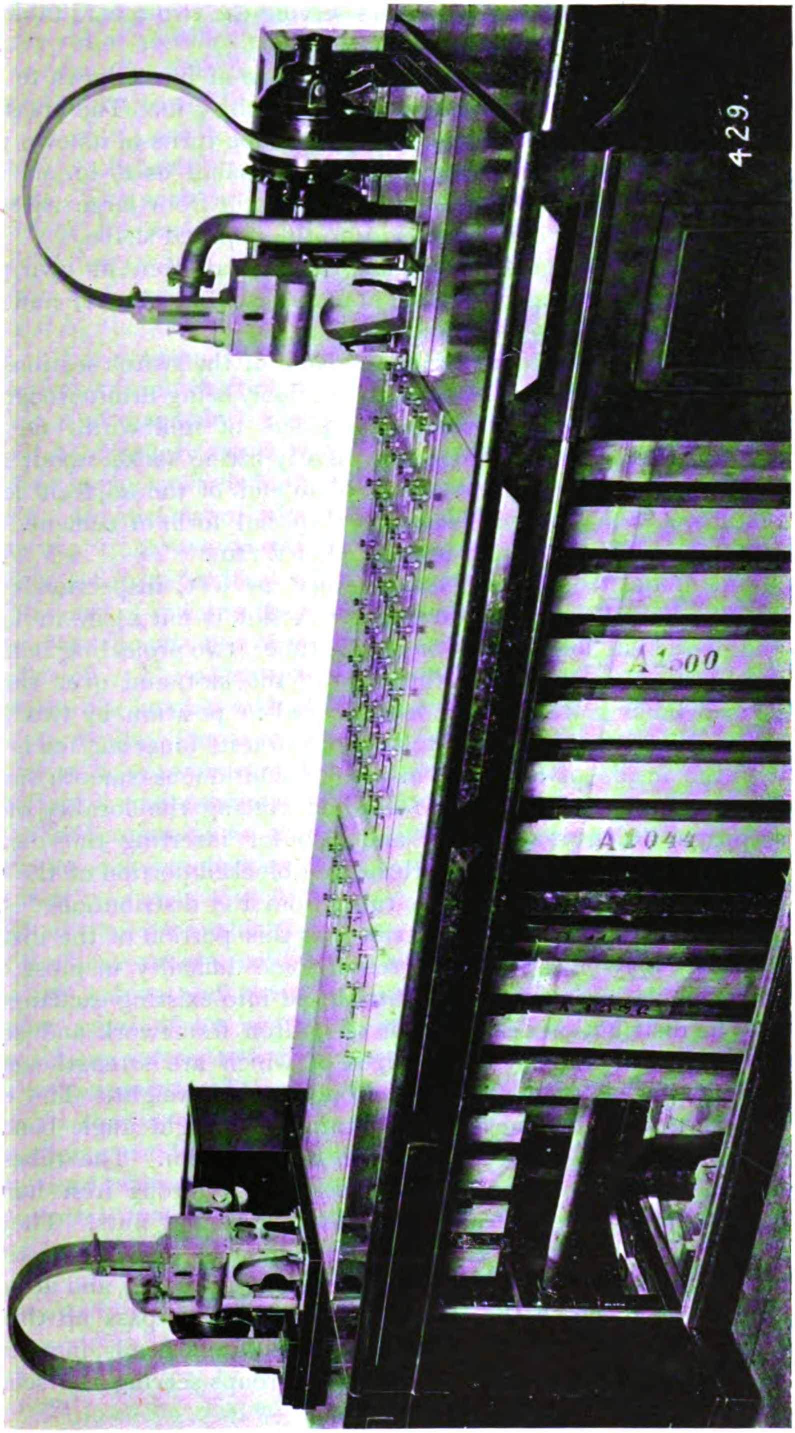
The electrical circuit is shown diagrammatically in **12**.

Each pressure valve on the distribution desk is, of course, fitted with a designation label "P," **13**, indicating the Trunk centres which are served by the tube.



14.—Pneumatic Ticket Distribution. Delivery Valve.

An illustration of the distribution desk is given in **15**. The front panelling has been removed to show the pressure tubes connecting the Trunk sections with the desk. The pressure despatching valves are clearly shown on the centre portion of the table, and the two



15.—Pneumatic Ticket Distribution. Distribution Desk.

rotary receiving valves and motors serving the two record tables are also illustrated.

The tubes used on the system are made of brass drawn to form a perfectly smooth rectangular tube $2\frac{3}{8}$ in. by $\frac{3}{8}$ in. The brass is of 26 gauge, S.W.G. At angles where the tube turns in its own plane the radius of the bends introduced is as small as 17 in. on a 90° angle. The bends for such angles are not cut from large sheets as might be supposed but are rolled into the required shape.

At other points where the tube turns away from its own plane (see **15**) the bending is a comparatively simple matter, and 180° angles are formed with a radius of 8 in.

The tubes are laid on edge at the back of the switch sections and are held in iron clamps screwed to the floor, being firmly wedged by hard wood blocks and separated by pieces of millboard. One end of each tube is expanded to form a tightly fitting socket about $1\frac{1}{2}$ in. in length for the reception of the plain end of the adjacent length of tube, and the joint is sealed by a special form of cement. The expanded end of a tube is illustrated at E (**10**).

At frequent intervals, about every 20 feet, inspection covers are fitted on the edge of each tube. A slot is cut $2\frac{1}{4}$ in. in length and of the full internal width of the tube; two projecting bolts are fixed in the tube, one on either side of the slot, and over these a flanged brass plate is fitted, and secured in position by two small nuts. When the flanged plate is in position its inner surface is flush with the inside of the tube, making a continuous smooth surface. The inspection chambers are used in tracing the locality of any stoppage which may occur, and also for inserting the clearing devices which must be drawn through a blocked portion of the tube.

The method of carrying the tubes from the distribution desk to the switch sections will be described, as this portion of the installation work may be expected to present some difficulty in most cases where similar systems may be introduced into existing exchanges.

The distribution desk is made of an iron framework and stands over a hole in the floor, the edges of which are strengthened by suitable steel joists to carry the concentrated weight. The tubes drop vertically from the desk and turn off in right angle bends in two groups, one towards each side of the room. The tubes are carried immediately beneath the ceiling by strong iron hangers bolted through the floor and secured by plates and nuts. They are arranged on the supports in echelon fashion to give access to the inspection chambers. Near the two sides of the room, and at points immediately beneath the trunk sections the tubes pass up through the ceiling again, and by means of two right-angle bends, in mutually perpendicular planes, form out into two groups serving the sections on either side of the distributing point.

The travel of the ticket in the tube is at the rate of about 24 ft. per second or 16 miles per hour. The number of tickets carried on one vacuum tube during a busy quarter hour averages about 650. The total number of tickets handled by the system during an average day is from 14,000 to 16,000. The nature and dimensions of the ticket are most important factors in the satisfactory working of the system. The surface of the paper must be highly glazed and non-absorbent, free from fluff, and of a springy texture, so that when the ticket is inserted in the tube the flap keeps open throughout its passage and delivery. Difficulty is quickly experienced and tubes blocked by the flaps of tickets straightening out after insertion in the tube. It is consequently of great importance that the nature of the paper from which the tickets are cut should be in all respects satisfactory, and that before the ticket is placed in the tube the fold should be carefully made to ensure the flap retaining its correct position in the tube during transmission.

The dimensions of the ticket which has been adopted after numerous trials are 5½ in. by $2\frac{7}{16}$ in., and the fold is made to produce a flap 1⅜ in. long. The thickness of the ticket is 6 mils.

The cost of running the system is small, as with careful handling stoppages should be very infrequent on a properly constructed installation. The adjustments of contacts for signalling and locking purposes are simple, and should not require much attention with fair treatment. The work required of the blower and of the three motors is, however, exceptionally heavy, for these parts are required to be in full and continuous operation from 8 a.m. to 8 p.m. daily, and it is therefore to be expected that minor repairs and overhauls will be needed periodically after the system has been in operation for a year or two.

The installation which has here been described comprises sixty-five pressure tubes, each fitted with separate despatching and receiving valves, and having an aggregate length of 3150 ft.; two vacuum tubes of an aggregate length of 72 ft. with twenty-four despatching valves, two rotary receiving valves, and the complete blower equipment. The number of man-hours per week required to maintain the system in its present condition averages twenty-four. These hours are divided between a competent mechanic, who attends to valve adjustments and the clearance of tube stoppages, and an experienced dynamo attendant, who attends to the motors, switch gear and blower.

It is understood that the saving of labour in the switch room is represented by the services of five operators. Although, of course, such economy is of the greatest importance, it by no means represents the full extent of the benefits derived from the introduction of the tube system. Expedition in the handling of traffic in a large exchange is of vital importance to the department, and the saving of possibly five minutes in the circulation of a ticket will go some distance, at any rate, towards cutting down delays which it is so necessary to avoid if the Trunk system is to be fully developed to meet the ever-growing needs of the telephone public.

My thanks are due to the Western Electric Company, Ltd., for their kindness in providing the photographs to illustrate this article.

SOME OBSERVATIONS ON TELEPHONE AND TELEGRAPH PRACTICE IN ENGLAND, MAY AND JUNE, 1911.

By ANGUS S. HIBBARD.
American Telephone and Telegraph Co.

THE short time usually allotted to the American tourist for visiting London and its vicinity is generally so fully occupied in seeing the many historical and interesting sights which must not be missed that the time remaining for business consideration is much restricted. This, at least, has been my experience on two previous trips, and I am now realising how much more valuable to me has been my recent visit, which gave opportunity, in a stay of about six weeks in London, to look more carefully into telephone and telegraph matters which have interested me so much. As regards the telephone, I am impressed with the change in the attitude of the public which has taken place during recent years, and which is still going on. About ten years ago it seemed to me to be a frequent practice for one telephone user to call another, with more or less difficulty, and ask " Are you there ? " Being assured by the other that he was " there," the caller would say, " I'll be right over, I want to speak to you." Four years ago I noted, in connection with a marked growth and improvement in the service, a growing disposition to go ahead and do the talking by telephone after the caller had found that the person desired was finally " there." This year I find conditions still further changed, the service being much extended and improved.

The " Are you there ? " expression, in its old sense, has largely disappeared, and, fortunately, has not been replaced by the useless " Hello ! " Modern relay switchboards, now generally used in the large exchanges, give a more rapid and dependable service, which suffers principally because it is furnished by two separate authorities, the Post Office and the National Telephone Company, a divided responsibility which, with the best possible intentions on both sides, cannot possibly give the best results.

This division of interest, one branch of which is so soon expiring, has evidently retarded the growth of the business, and to a considerable extent has kept back the necessary provision of facilities required to handle it to the best advantage. There are many evidences that the public, meanwhile, is acquiring the telephone habit, and following the consolidation of the service into one organisation under the Post Office, an unprecedented growth will, I believe, take place. The policy announced by Mr. Samuel, Postmaster-General, that the Department proposes to proceed with the telephone as a great commercial enterprise on broad and comprehensive lines, gives assurance that under his direction this development will be speedily taken in hand. London, therefore, presents to-day probably the largest and most interesting problem in telephone engineering. It will be a great work to prepare the plans and specifications for a twenty-year growth, to fix exchange boundaries, plan for main subway and distribution work, and prepare exchange equipment and cable and wire facility plans adequate for each situation. Other cities in Great Britain present the same problems, now made the more interesting from the fact that all the wire facilities for the Post Office, both telephone and telegraph, may be planned for and co-ordinated into one comprehensive system with marked advantages to both branches of the surface. Members of the staff may be congratulated upon their opportunity to participate in this interesting work.

While in some minor points the Central Exchange equipments are not exactly of the kind now used in America in like situations, the installations are very similar, and from cable heads through distributing boards and relay racks to final A and B boards, the large offices are practically simliar to those in the States. The good discipline and attention of telephonists while on duty was apparent in every office I visited, and my observations indicated that their courtesy was unfailing.

My special task was to look into the workings of the telephone and the telegraph where the two systems were used together to transmit or receive telegrams, and I found in the routine and manner of working much that was interesting and instructive.

One feature which has so worked itself into every-day practice as to become involuntary, is the use of analogy in making certain the spelling of words where spelling is necessary. In upwards of fifty offices visited I found telegrams being transmitted and different words or phrases treated in this manner so easily and so surely that there seemed to be no possible doubt at either end of the line as to the correctness of the message, and in the many tests and observations made I did not note a single error in address, message or signature. The method of analogy is not new, but in America it seems to be resorted to as the last way of making sure of some one letter when other means have failed, whereas English practice trips it off at once for all the letters of any difficult word, and does it quickly and accurately. When I first heard my test message being sent by a clerk in a London branch post-office located in a greengrocer's shop, I did not know whether I was listening to a compendium of proper names or an order for red herring, but in a moment, realising what was going on, the letters were made absolutely certain, and very soon "A for Alfred," "C for Charley," "E for Edward," etc., appeared as instant and involuntary pictures of the letters designated. I had many evidences that the telephone users were also employing the same means of making sure in telephone conversations of all kinds. Indeed, on one occasion a clerk in a district messenger office selling me some theatre tickets across the counter said, "There you are, sir, row G., G. for George, 8 and 9, thank you sir," and I was perfectly sure of row G., because he said "G. for George." This extended reference to analogy may seem a bit trivial at first, but observations of its practice convinced me that in England it has grown into a quick and accurate means of making sure of just what is being said or heard over the telephone, and has so grown into the service that its use is understood and expected by all.

The Post Office practice, extending over a period of several years, has shown that telephones are successfully used instead of telegraph instruments in handling telegrams at branch offices. The telephone was very generally preferred by the staff employed at nearly every office I inspected. At one office where I was told the sounder was preferred, the preference disappeared when the post-master was informed that the salary was the same, when he said, "Oh! of course, in that case I prefer the telephone." A number of tests showed the telephone to be quicker than sounder work, while it did not require the special skill of a Morse operator, and the assurance of correctness by repeating back the message was much appreciated and commented upon. Its greater use for short-distance telegrams seemed to be desired in all the districts I visited. The telegraph workings in the large offices interested me very much, especially results from the Wheatstone, Creed, and Baudot systems.

The telegraph concentrators were most interesting, and their application, as I saw them, excellently worked out. The greatest delay in handling telegrams is no doubt caused by the prevailing use of code addresses making reference to books of code words necessary before telegrams can be delivered. This delay under the present system seems unavoidable, but it must cost fully as much as the sum received annually for the registration, and involves the greatest delay experienced in any part of the telegraph system. I am sure I should prefer the American plan of free addresses, especially when telephone addresses are used, making immediate delivery by telephone possible. The number of telegrams between two points in London, while decreasing on account of the more frequent use of the telephone, still seems very great. Telegrams costing a shilling or more, which could be telephoned direct for twopence, are still in evidence. The adoption of a telephone address, recommended by the Committee investigating telephone deliveries, will do much to speed up a considerable proportion of the London service.

Each day of my visit presented opportunity to investigate matters which were interesting and instructive, and I shall watch with renewed interest the important developments of the service which are anticipated in the near future.

I wish to express to Mr. Samuel, Postmaster-General, and to his staff and the officers of the National Company, my sincere thanks for their cordial reception and the facilities afforded for the inspection and study of the problems in hand. For myself and associates I may say that we appreciate the opportunities we have had in the past of meeting in America representatives of our craft from England, and hope there may continue to be frequent visits and renewals of the acquaintances and friendships so pleasantly made.

HOLLOWAY FACTORY: VISIT OF ENGINEERS FROM NORTH METROPOLITAN DISTRICT.

By the courtesy of the Controller of Factories some forty members of the Engineering Staff of the North Metropolitan District recently visited the Post Office Factory at Holloway. Although the factory is not large enough to manufacture any considerable proportion of the apparatus required by the rapidly developing Engineering Department, in addition to its principal function of maintaining the existing plant, it has a wide range of activity, and the work of the shops is conducted on quite up-to-date principles.

The original factory buildings are not of modern construction, and the more recent additions were not primarily designed for use as a factory, hence there are certain features in the lay-out of the shops which are not ideal; nevertheless, it is obvious that careful consideration has been given to the arrangement of the workshops and stores with the object of making the best of existing conditions.

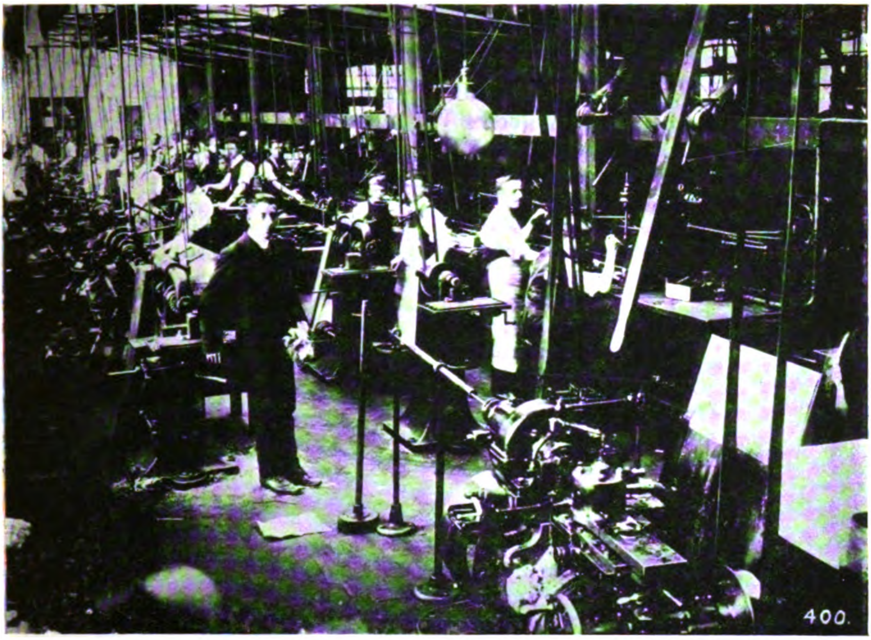
In the newer building the motive power is electric. The lathes and other machinery are grouped according to the requirements of production, and each group is driven by a motor of suitable rating. In the older building the beam engines and Cornish boilers installed when the factory was opened in 1887 are still doing good service. From the point of view of the present-day steam engineer, this arrangement seems at first sight an uneconomical one, but inasmuch as the shops to be supplied with power are compact and there is a constant and considerable demand for steam for heating vats, pans, etc., the system is more economical than might be expected, and it was stated that the cost of power delivered at the main shafting was less than *2d.* per B.H.P. hour, without taking credit for the heating value of the live and exhaust steam used for other purposes. It is understood, however, that as energy can be purchased locally for about *1d.* per K.W.H., electric driving will shortly be made general.

The shops are well lighted and ventilated, and in winter are heated in part by hot water and in part by exhaust steam. The artificial lighting of the workshops is provided by high-candle-power metal-filament lamps for general illumination, supplemented by low-candle-power wire lamps for bench work. The combination is very effective, for whilst it gives to mechanics the benefit of individual lighting, it lends itself to the maintenance of adequate supervision.

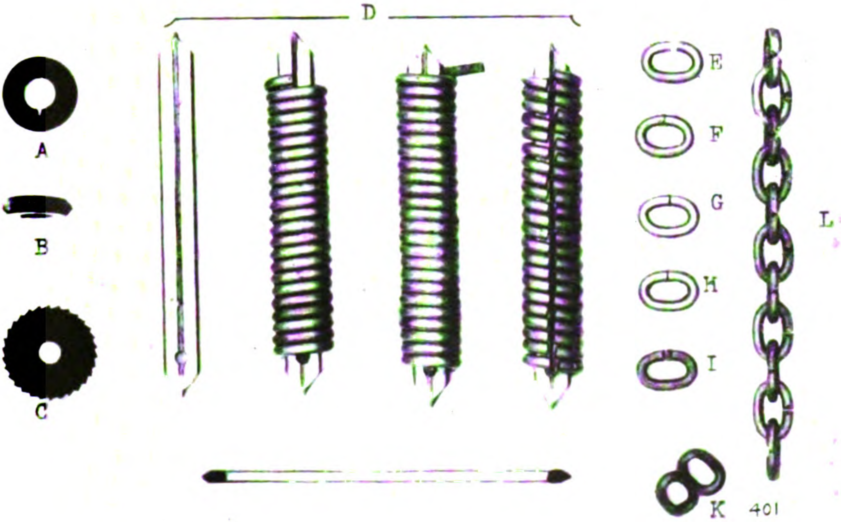
Throughout the visit one was constantly reminded of the magnitude of the changes which are in progress in our own Department. We all know that the telegraph service has not yet reached maturity, but already its younger brother (or sister) promises to attain far greater proportions.

With the growth of the telephone system the machine-shop has assumed importance and even pre-eminence in the scheme of an instrument factory. It was at the machine-shop that we started our tour of inspection. This shop is situated on the ground floor in a position convenient for the reception of raw material and for the distribution of the machined parts; it is furnished with profiling machines, milling machines, power presses, automatic screw-making machines, and a range of automatic and turret lathes, and at the time of our visit all seemed to be full of work. The accompanying illustration, 1, shows a part of the shop, and in the foreground one of the Herbert automatic lathes upon which details for various telephone parts are being manufactured.

From among the many interesting devices which were exhibited and explained, it is difficult to single out any one as more interesting than another. Many of the special tools which were available for inspection (some of them at work in the machines) showed very considerable ingenuity in design and construction; others, again, of equal originality and cuteness had obviously been developed from the bench of the skilled mechanic rather than from that of the machine tool-maker. Two typical cases of general interest may be cited.

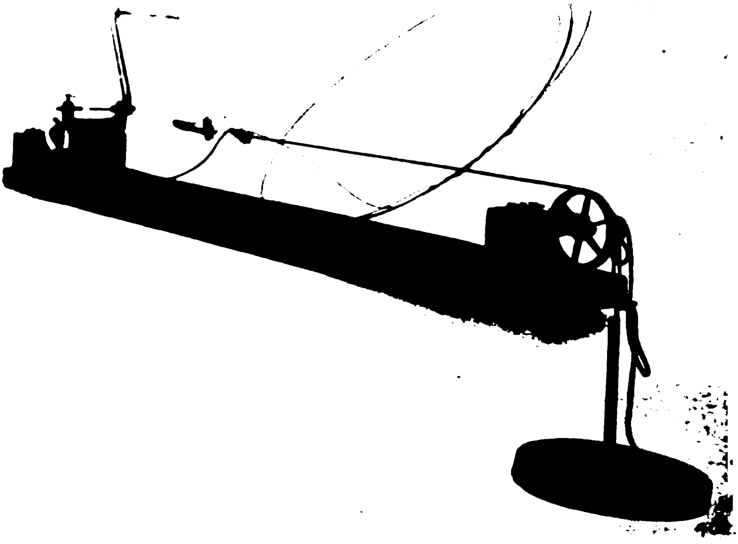


1.—Holloway Factory—Machine Shop.



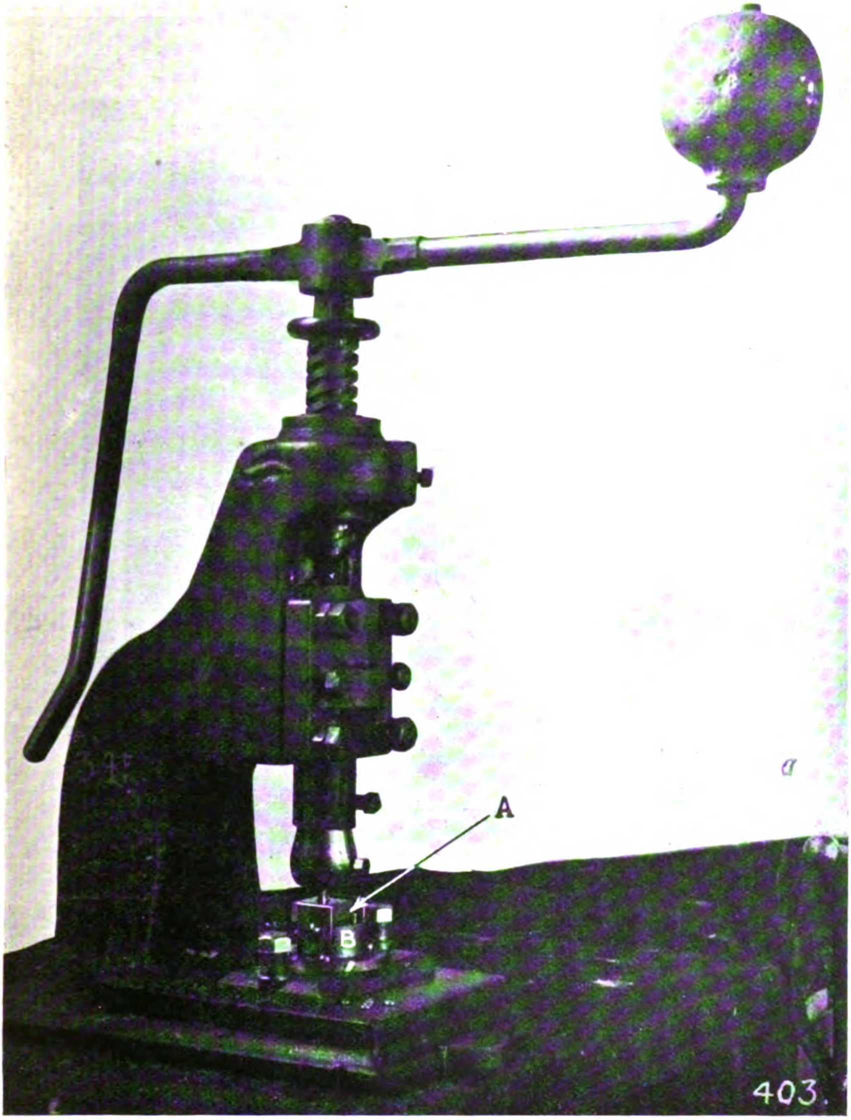
2.—The Making of a Chain for a Wheatstone Transmitter.

The first, which emanated from the mechanic's bench, is a set of tools for making chains for Wheatstone automatic transmitters and receivers. As is well known to telegraph engineers, these chains are endless, and the duty thrown upon them is very severe, since they not only carry a heavy weight but are subject to the very irregular stresses due to hand winding. Further, it is a condition that they shall be repairable by an unskilled person if at any time broken in use. This latter condition renders it essential that the chain shall be made up of open links. The problem of making an open link chain light enough for the requirements and yet strong enough to withstand the load of everyday practice was not an easy one. The way in which it was solved is shown in detail in **2**. The links are made from pianoforte wire 84 mils in diameter, wound on a shaped mandrel D, in a device shown in **3**, and afterwards slotted along the central groove by the slitting saw C. The links thus formed are shown at E, and after having been pressed flat, F, they are threaded on an arbor, and by means of a punch the saw gap is closed G. The next operations are performed on the press shown in **4**. The link is placed in the die A, and the punch carries it through two operations—in the first it is closed upon the nose of the punch which determines the inside dimensions, and in the



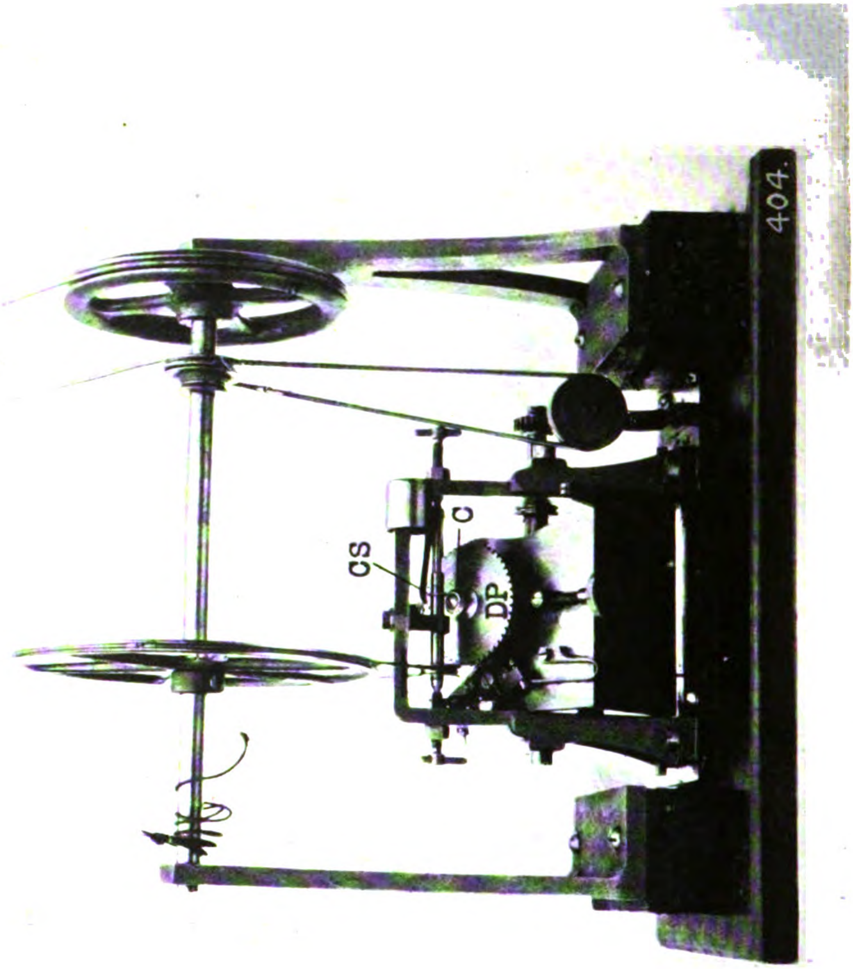
3.—MAKING A CHAIN FOR A TRANSMITTER—WINDING THE PIANO-WIRE ON TO THE MANDREL.

second it is carried into the matrix B, where it is formed as shown in **2** H. The links are now ready to receive the double **V** shown in I, which enables them to be linked together as shown in K and L.



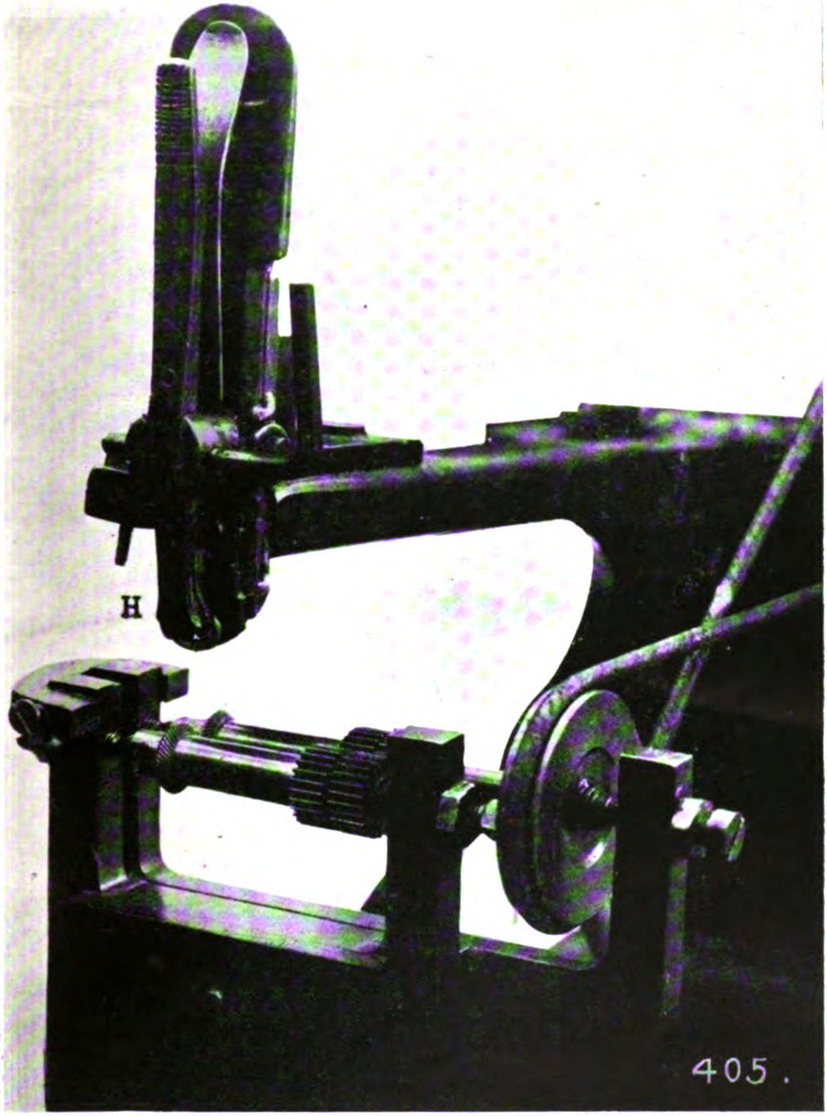
4.—Making a Chain for a Transmitter—a Link in the Press.

From the method of manufacture indicated in the foregoing, it will be observed that each link originally formed part of a helix, and although most of the bias put upon the link when originally wound is corrected by subsequent processes, it retains enough original sin to introduce into the finished chain a permanent liability to twist, which would be highly objectionable owing to its tending to throw the chain off the sprocket-wheel during the winding of the weights. To counteract this two kinds of links are used, one kind made from right-handed helices and the other from left-handed helices. By



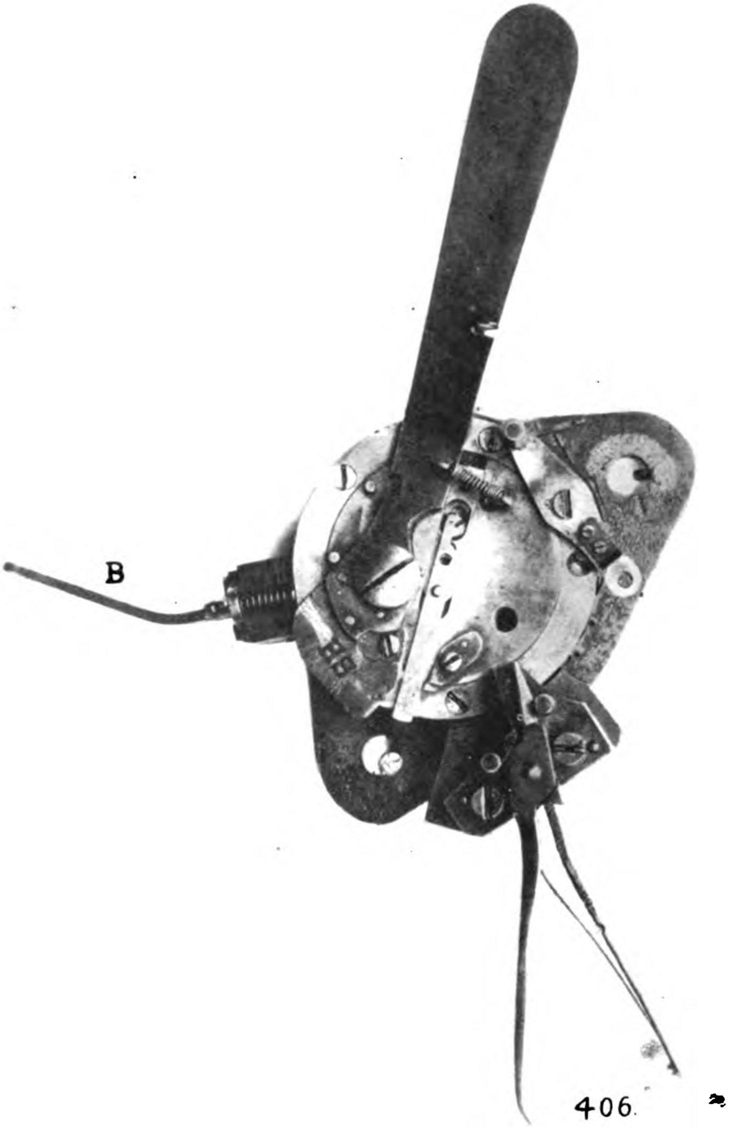
5.—The Making of a Chain for a Transmitter—Production of the Cutters used for Making the Double V in the Links.

assembling alternately right- and left-handed links all tendency of the chain to twist is eliminated.



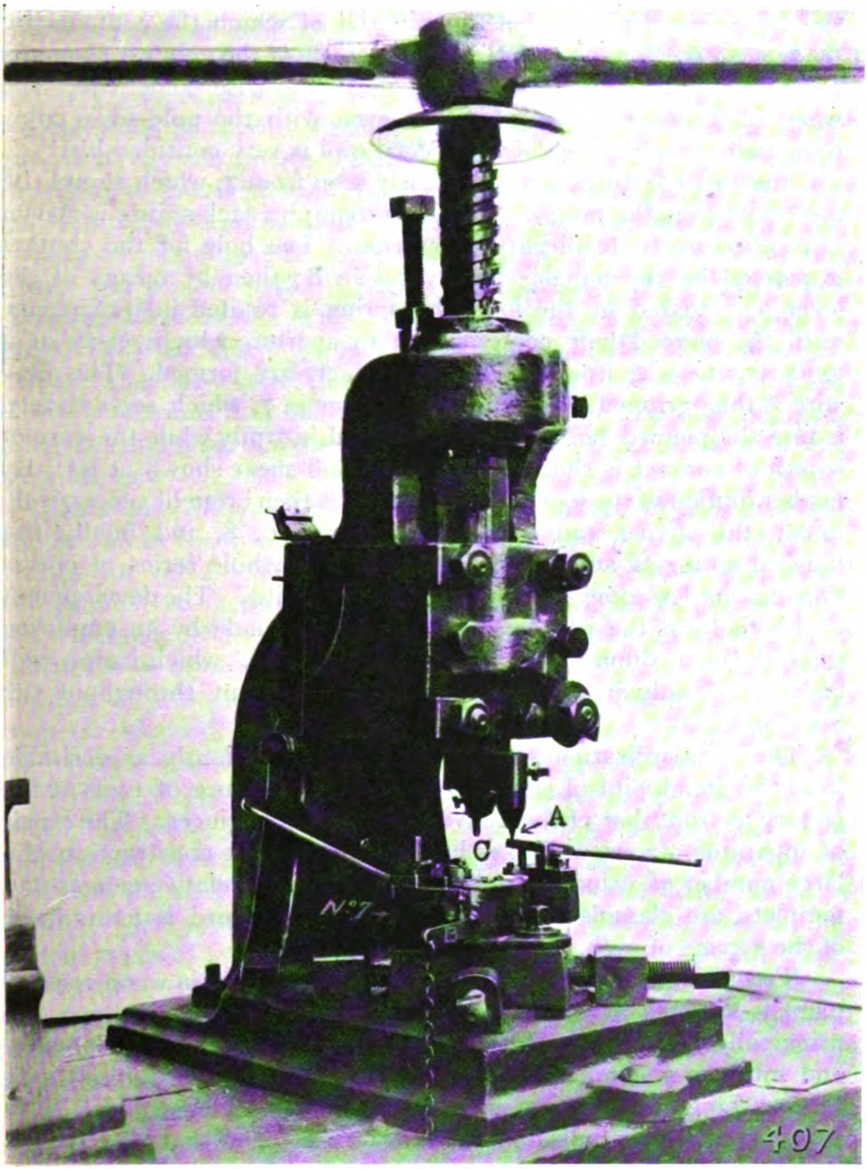
6.—Making a Chain for a Transmitter—Cutting the Double **V** in a Link.

As illustrating the origin of the above-described processes, this description would be incomplete without a word on the production of the cutters and the device for cutting the double **V**. A cutter-blank is shown at A, **2**, and a finished cutter at B. The production of the cutter is illustrated in 5. In this photograph the cutter is shown under the diminutive circular saw CS, carried by the horizontal spindle, and is mounted upon a divided plate DP, which is propelled by a click and pawl arrangement, and rocked to



7.—Tool for Fitting Contacts of Valuable Metal to Jacks with Maximum Economy.

its work by a suitable cam. Each link is separately clamped in the holder H shown in the adjustable head in **6**, and when brought into position the double **V** is cut by two cutters mounted on parallel arbors. The links are then hardened by a special process, and after the chains have been formed and tested they are placed in a rumble to brighten them up.



8.—Punch Making the Hole in a Jack-spring to Receive a "Contact."

The second case is typical of the tool devised by the machine tool-maker. It is used for fitting the contacts to jack and other similar springs, and is illustrated in **7** and **8**. The *raison d'être* of this ingenious device is that the material of which the contacts are made is so precious as to call for the exercise of the greatest economy in manipulation. This was particularly the case some years ago when platinum was employed, but even with the gold-silver alloy now used the advantage of the special tool is very considerable.

The main features may be clearly seen from **7**, which shows the tool apart from the press. In this photograph a jack-spring is shown in position ready for the first operation. The hole for the contact is pierced by the punch, shown at A in **8**; then by means of the lever B, actuated by the foot, the spring is rotated in its carriage until the pierced hole comes below an aperture which serves as a guide for the wire from which the contacts are formed. The alloy wire is then gripped by the nippers shown in **7**, which serve to feed it into the pierced hole and also to hold it firmly while the correct length of contact is sheared off by the hand-shear shown at HS. By further motion of the foot-lever the spring is then brought successively under the shaper and the riveting punch C, **8**, and finally the finished spring is automatically ejected, the whole series of operations taking less time to perform than to describe. The development of this tool was the outcome of a suggestion made by an employee through the medium of the "Awards Committee," which is now well known not only in the Engineering Branch but throughout the Service.

The standardisation of wearing parts is obviously as desirable from the standpoint of economy in the manufacture of tools at the factory as from that of the convenience of the engineer. The repair of apparatus of various makes has necessitated the construction of a large number of valuable tools, which, with the relative gauges and templets, are classified and numbered, and a record is maintained of the service of each.

Woodworking Shops.—These are small, as the main woodworking plant is situated at Mount Pleasant, and the Holloway shops deal principally with repairs. They contain, however, morticing, tenoning, and mitering machines, drying ovens, and trimming machines. In the polishing shop modern processes have almost ousted the more expensive French polishing, and it was evident that the newest methods were receiving appropriate attention.

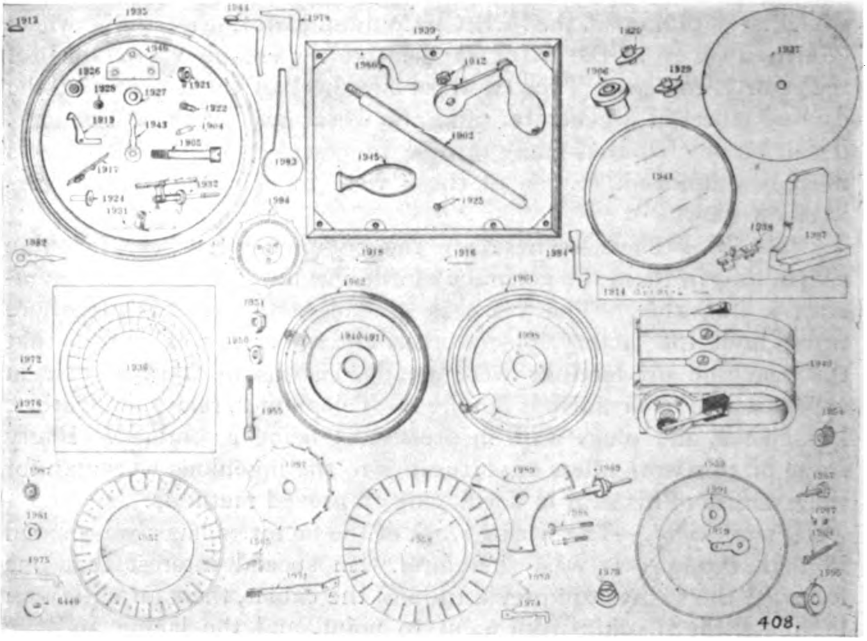
Wheatstone Shop.—The name of this shop is rather of historical significance than descriptive of its present-day activities; but it still contains a few employees who were associated with the pioneer telegraph work of Sir C. Wheatstone and Mr. Stroh in the seventies. At present Wheatstone apparatus, Hughes instruments and Baudôt apparatus constitute the bulk of the work. In this shop the skilled mechanic is still supreme, for although machine-produced parts are accurate and cheap, they lack the fine finish which is essential in the wearing parts of delicate apparatus. The parts produced in the Wheatstone shop exhibit a high degree of mechanical skill. All are carefully gauged before issue, so that they may be relied upon to replace worn parts without difficulty. For some details the same gauges have been in use for thirty years. It was not surprising, therefore, to find in this shop a store reserved exclusively for gauges and templets. Another interesting feature was represented by the various devices employed for cutting wheels. If one contrasts the wheel and pinion of the A.B.C. Communicator, the escape wheel (German silver) of the A.B.C. Indicator, the escape wheel (steel) of the A.B.C. Indicator Type A, the star wheel of the perforator, the driving wheel of a generator, and the worm gear of an interrupter, it will be obvious that many diverse processes and specialised tools must be employed. Some of these were in operation, and others were on view.

Assembling Shops.—These are the complement of the machine shops, and in them the accuracy of the machine production demonstrates its value. The work is graded, and here, as elsewhere throughout the factory, piecework is the rule. It was obvious that the machine productions were arranged so as to allow no margin except where fit or finish is required. Telephones, relays, indicators, keys, jacks, and plugs were in process of being assembled. Every stage of this work offers opportunities to the ingenious workman for the exercise of his skill in developing improved methods.

Wiring Shop.—The wiring work of the factories has always stood in high repute. It was, therefore, with special interest that one followed the systematic preparation of the cables, their formation on templets, the shaping from point to point, and the lacing and the waxing of the ends in readiness for connection to the tags of the various types of switchboards in which they are to be fitted. The factory colour-scheme as applied to the different types of switchboards was explained, and also the tests to which the wiring is subjected before it leaves the factory. The whole bears evidence of having been carefully systematised.

Repairs form nowadays the most important item in the work of the factory. Apparatus of almost every description was under repair in the various shops, for although there are "repair" shops in which the bulk of the repairs is undertaken, there is no rigid line of demarcation between construction and repair shops. A more definite line separates telephone from telegraph work than that of construction from repairs for reasons which will be apparent.

All apparatus sent in for repair is carefully examined in the first instance by specially qualified officers representing jointly the Engineer-in-Chief and the Controller of Factories, and the details of the repairs to be undertaken are specified before an order is placed. The specification indicates the estimated cost of the repairs, which are divided into three main classes, known as "complete," "partial," and "minor." These three classes are grouped in accordance with definite percentages of the rate-book value of the apparatus which represent the limiting cost allowed for repair work in each class. Items which cannot be repaired within the limits of cost for "complete" repairs are set aside for "scrapping," and it is interesting to know that much better terms are generally obtained by dismantling the apparatus and selling the parts as "material" than by attempting to sell the items complete. A system of strict cost-accounting provides against any excess repair costs passing undetected or unexplained.



9.—STORES METHOD—DETAILS OF ABC PARTS WITH NUMBERS USED ON REQUISITIONS.

In the telephone shop interest was centred on the construction of transmitters, particularly on the preparation of the carbons, and in the adjusting and testing for speaking efficiency. Telephones of every variety were under treatment, for at this "hospital" it seems to be possible to give a new lease of life to the most hopeless case.

Wireless apparatus has from time to time been constructed in the factory for the prosecution of departmental experiments. An interesting collection of apparatus and working models was shown. These included a Hertz oscillator, a Hertz resonator, complete Marconi transmitting and receiving sets, and various forms of carbon, nickel-silver and electrolytic coherers and induction coils.

Coil winding is carried out by girls in a separate shop. The wide range of work done in the factory furnishes this section with considerable diversity of work. Simple winding constitutes the bulk, but there is also much differential winding for galvanometers, detectors, Wheatstone automatic apparatus, transformers, etc., and double-winding for Wheatstone bridges and other non-inductive requirements. Lacquering is done also by girls. The "Aerograph" spraying apparatus is used in increasing measure both for applying lacquer and japan. It was stated that the Holloway Factory was the first to make successful use of the Aerograph for lacquering purposes.

Stores.—These are situated in positions suitable for economical distribution. All "parts" are numbered and systematically grouped. For the assistance of employees blue prints of the details of apparatus have been prepared. These are illustrated in 9. All parts are numbered, so that on demand dockets list numbers only are required.

Cost-accounting.—The system was briefly explained. Card systems have replaced ledgers for stock records, cost-accounting, service records, and piecework prices. Departmental red tape could still be seen protruding here and there, but what Government Department could hold together and maintain its dignity without it?

A word of appreciation is due to the Superintendent for the arrangements he had made for our comfort, and to the foremen who conducted us through the shops with evident interest in, and appreciation of, the technical details likely to interest engineers.

THE DECAY AND PRESERVATION OF TIMBER

By W. H. Matthews, B.Sc.

(*Continued from p.* 169.)

II. The Agents of Decay.

Although the explanations of the decay of timber given in the various text-books of telegraphy and telephony are mostly inaccurate and defective no great harm is done, as the reader is not usually much concerned with this point, but is more anxious to know what is considered the best method of preservation. When we are dealing with the question a little more fully, however, it is worth while to inquire into the nature of the factors of decay in order to judge to some extent what treatment is likely to be most effective in overcoming them.

Neglecting such obviously mechanical causes as torsion and abrasion, and such special causes of damage as woodpeckers, beetles, and other boring creatures, we may confine our attention to the agents causing those changes of the substance of the wood in virtue of which it is said to "rot." The agents of destruction are all members of a large and varied class of plants named "Fungi," whose common characteristic is the complete absence of chlorophyll, the green substance by means of which ordinary plants are able to assimilate the carbon dioxide of the air—one of their chief sources of food.

FUNGI.—The lack of chlorophyll makes fungi dependent upon other organisms for their supply of carbonic food. Those which derive it from living organisms are called parasites. These include in addition to microscopic forms such as the "blights" of potatoes and salmon, the ringworm of human beings, and gigantic species as those which one sees protruding from forest trees.

Those which derive their carbon from dead organisms are called "saprophytes" and it is with certain of these that we are now concerned.

DESCRIPTION OF A FUNGUS.—In order to make clear the chief points about wood-destroying fungi, it will be most convenient to describe one as a type and indicate the way in which others differ from it. In **10** is shown diagrammatically a fungus which is typical of a very large group, including the common mushroom and one or two of the wood-destroying fungi. Two main portions may be distinguished—the internal portion, growing in the timber or other nutritive substratum, and the external portion growing in the air. It is the internal portion, or *mycelium*, which does all the direct damage. The external portion, or *sporophore*, is only concerned with the manufacture and distribution of the tiny "spores" by means of which the fungus can reproduce itself in distant places.

The mycelium consists of an interlacing system of fine tubes appearing to the naked-eye as a silky or felt-like mass of white threads; these threads are called "hyphæ" and are shown in **11** and **11*a*** highly magnified. Each hypha is seen to be composed of a thin transparent tube of a substance allied to cellulose, divided at intervals by cross walls into distinct cells, each containing, as in higher plants, living protoplasm and drops or granules of other substances. Here and there are curious outgrowths forming connections between one cell and its neighbour, called "clamp connections."

The hyphæ absorb from the surrounding medium the available nutrient materials, and their free ends grow in length and, branching at intervals, seek out fresh food stores as the immediate supply becomes consumed.

This vegetative growth may go on for a considerable time, no external signs being visible, but under suitable conditions certain of the hyphæ will at length emerge into the atmosphere, and becoming closely interwoven, will form a structure whose function is to bear spores, and which is therefore named the *sporophore*.

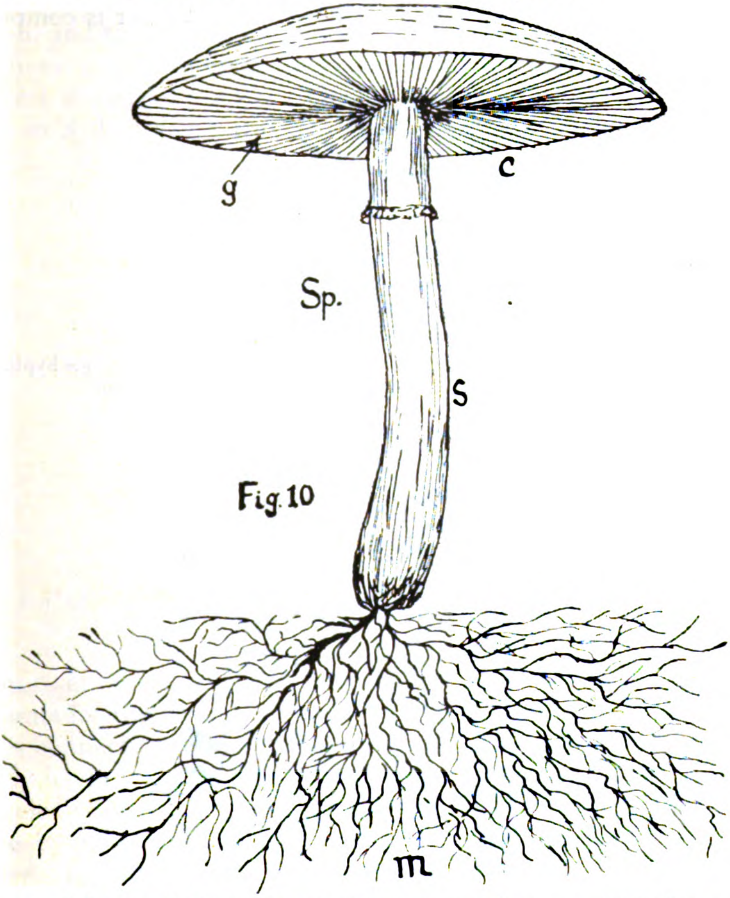


FIG. 10.—A fungus of the mushroom group: *m*, mycelium; *sp.*, sporophore; *s*, stalk; *c*, cap; *g*, "gills" or "lamellæ"—radiating plates upon which the spores are produced.

The shape of the sporophore varies considerably according to the species. In the type shown it is differentiated into a "stalk" and a "cap," but in other closely allied members of the same order it may have altogether different shapes. The structure of the essential part of it, however—the actual spore-bearing tract—is similar throughout the order to which the fungus belongs. In this case it takes the form of a series of radiating plates called *lamellæ*.

If the cap of a ripe mushroom be placed, plates downward, on a sheet of white paper for an hour or two, there will be found on removing it a kind of dark-purplish impression of the radiating plates. This is due to the multitudes of tiny spores which have fallen from the plates on to the paper.

If we examine thin sections of the plates with the microscope (**12**–**12***b*) we see that whilst the bulk of their substance is made up of an irregular aggregate of hyphæ, the outermost layer is composed of the ends of hyphæ arranged in a regular manner. Some of these are larger than the others, and possess four minute pegs, the tips of which swell out and form spores which, when mature, become detached and fall off. A "spore" serves the same purpose as the "seed" of flowering plants, that is, it is capable of germinating under favourable conditions, and forming a plant similar to its parent, but

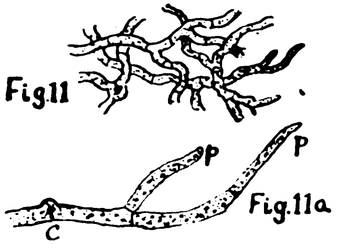


FIG. 11.—A piece of the mycelium enlarged. FIG 11*a*.—Part of a single hypha further enlarged: *p*, growing points; *c*, a "clamp connection."

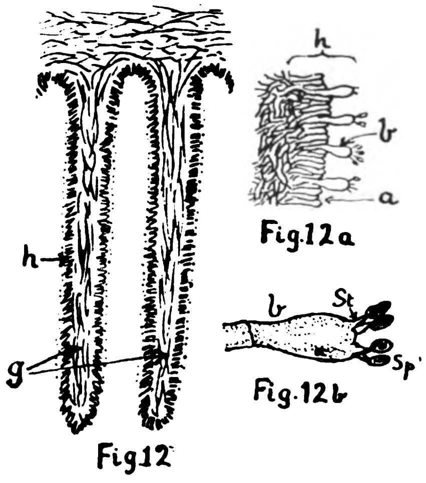


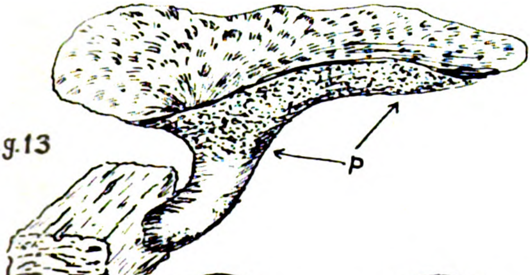
FIG. 12.—Tangential section through two gills: *h*, hymenium, or spore-producing layer. FIG. 12*a*.—Portion of hymenium enlarged: *a*, ends of ordinary, or sterile, hyphæ; *b*, a basidium, or fertile hypha, bearing four spores. FIG. 12*b*.—A basidium highly magnified: *st*, sterigma, or little peg, bearing a spore; *sp*, spore.

it differs from a seed in consisting merely of a single cell of microscopic size, whereas a seed is a complicated structure composed of many, often thousands, of cells.

The number of spores given off by a single ripe sporophore during the course of a few hours is enormous. An ordinary large mushroom may produce a number exceeding that of the human population of the globe, whilst the number thrown off by one of the large "bracket" fungi has been calculated at eleven thousand million, and the figures for certain other fungi run into billions!

These spores are exceedingly light, and are carried about by the slightest motion of the air. Thus they may easily travel hundreds of miles in a day, and reproduce their species, under proper circumstances, at great distances from the parent plant. This fact accounts for the sudden appearance of the fungi in isolated places.

Fig. 13



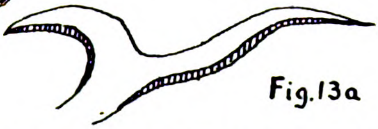


Fig. 13a

FIG. 13.—A species of *Polyporus* growing on a piece of wood; *p*, pores.
FIG. 13*a*.—Diagram of same in section.

In connection with the subject of spores, it may interest students of physics to learn that the first direct verification of Stokes's law for the velocity of small spheres falling in a viscous medium was recently made by a botanist in his researches on fungus spores (A. H. R. Buller, 'Researches on Fungi,' 1909).

WOOD-DESTROYING FUNGI.—A fungus belonging to the same order as that which we have selected for a type is *Lentinus lepideus*, which destroyed the paving blocks of Birmingham a few years ago. The blocks, which were of pinewood, had been dipped in creosote, but had not been injected. They rotted to such an extent that they would crumble in the fingers, and it became imperative to take them all up and to re-pave the area. When Dr. Buller, who investigated the matter, kept some of them in a close moist atmosphere for a time the sporophores of the fungus soon appeared.

The majority of the wood-destroying fungi belong to an order in which the spore-producing layer is distributed over the inner surface of the little tubes which appear from the outside as pores, circular or polygonal. A common fungus of this order, named *Polyporus*, is shown in **13** and **13***a*; it infests oaks. The most well-known and greatly dreaded member, however, is *Merulius lacrymans*, the fungus

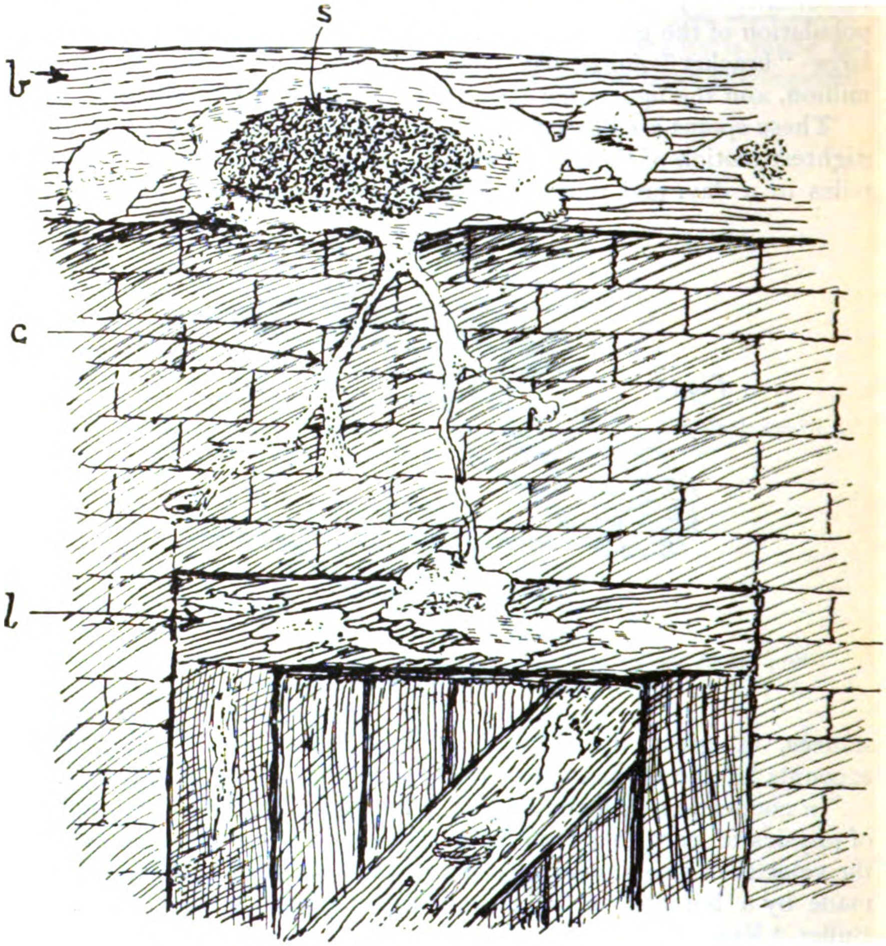
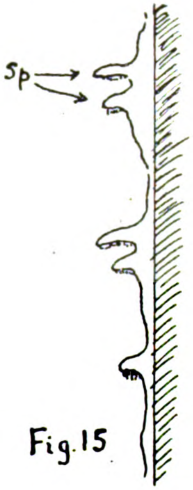


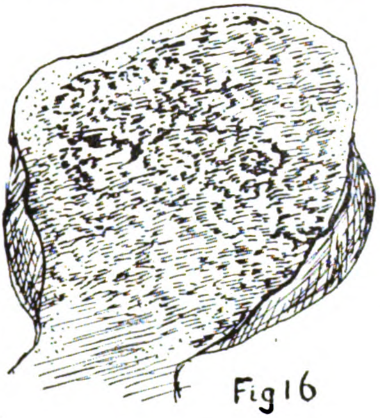
Fig. 14

FIG. 14.—*Merulius lacrymans*, the fungus of "dry rot," growing in a beam, *b*, producing a sporophore, *s*, and sending out conducting strands, *c*, over the brickwork to found new colonies as at the lintel, *l*.

of "dry rot," which is shown in **14–17**. This fungus is very common in cellars and mines, and in badly ventilated situations generally. It usually attacks coniferous timber, but may also live on oak and other hardwoods. Its earliest indication is the appearance of "red stripe" in the timber when sawn. Later on the fungus appears at the surface of the wood and forms white felted tufts, sheets and strands, which later assume a dirty greyish hue. (In the case of *Polyporus vaporarius*, which forms similar sheets, the white appearance is retained throughout.)

14 is a rough sketch of a specimen at an advanced stage. Originating in the beam at the top the fungus has sent out "exploring" or "conducting" strands over the brickwork, and one of these has attacked the lintel of a door and passed thence to the door itself. The sporophore of this fungus consists merely of a portion of the felt-like mass mentioned above, although, as shown in **15** and **16**, it may assume a projecting bracket-like form. The spores are produced in irregular depressions or folds, corresponding to the tubes of *Polyporus*, and resemble snuff in appearance. They are so small that four millions of them occupy only one cubic centimetre.





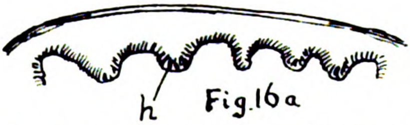


FIG. 15.—Diagram of dry-rot fungus growing out of a vertical surface and producing horizontal sporophores, *sp*.
FIG. 16.—One of the sporophores seen from below.
FIG. 16*a*.—Portion of the same in section.

The "dry-rot" fungus resembles an electrical "dry" cell in one particular, namely, that when quite dry it cannot work; it must have moisture. Its specific name, *lacrymans* ("weeping") has reference to the drops of water which it excretes in abundance when growing in a sufficiently moist atmosphere.

In **17** is shown the appearance of its spores under the microscope, and also a peculiar characteristic of its hyphæ by which it may often be recognised from an examination of infected timber when externally it has not made its appearance.

When the spores alight upon a piece of timber they will germinate if conditions are favourable. The chief necessities for germination are (1) stagnant air—in the total absence of oxygen they cannot live,

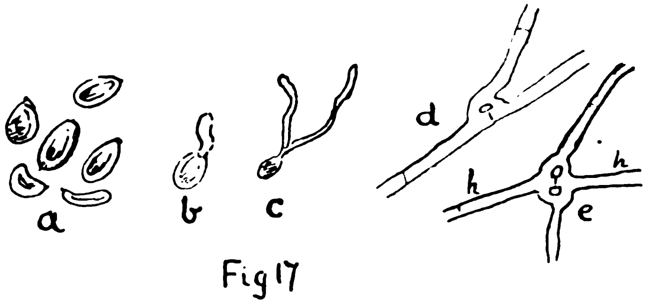


FIG. 17.—*Merulius lacrymans*. *a*, spores, highly magnified; *b* and *c*, germinating spores; *d* and *e*, hyphæ showing branches growing from the "clamp-connections.

and if exposed to draughts they are likely to be blown away or to perish from desiccation; (2) moisture in the wood or in the atmosphere; (3) the presence of minute traces of some alkali.

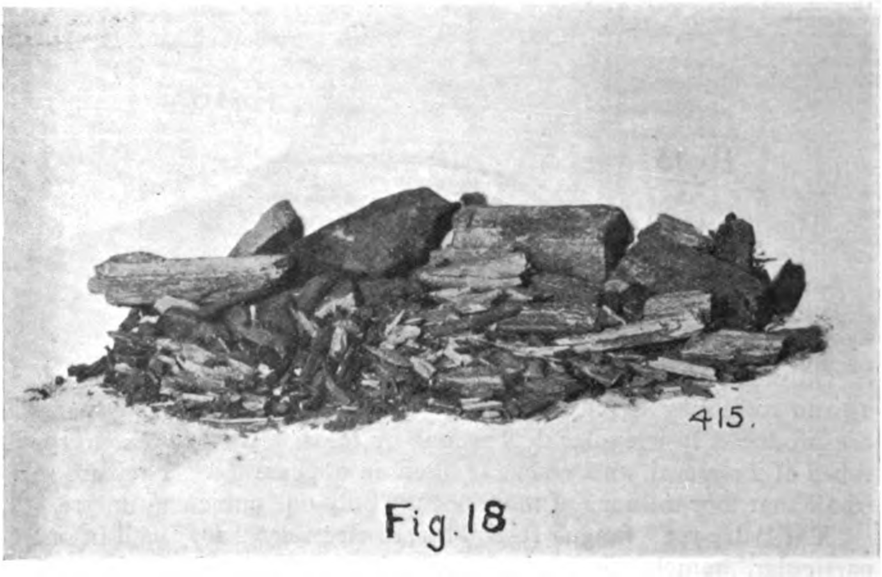


FIG. 18.—Portion of base of silence cabinet rotted by *Merulius lacrymans*.

THE OPERATION OF DECAY.—The hyphæ of the dry-rot fungus attack the walls of the wood-cells by giving forth certain ferments (see p. 168) which decompose the lignose and cellulose of the cell-walls, leaving only the gums, resins, tannins, etc., which are very friable. When the fungus has exhausted any part of the timber the hyphæ in that portion shrivel up, and after a time it is difficult to find any traces of them. The timber is then in the "dry rot" condition and is so brittle that it will easily crumble between the fingers.

18 shows a portion of the floor of a telephone cabinet reduced to this condition.

The cabinet was placed in position in April, 1906, and the base had rotted completely by June of this year.

The floor had not been ventilated. If free circulation of air had been allowed the fungus could not have thrived.

Other fungi have rather different modes of destroying the wood; for instance, *Bulgaria polymorpha*, which may often be noticed in the form of little black cups on oak palings, converts the lignose of cell-walls into cellulose and removes the calcium pectate that binds the cells together (see p. 168).

There are several other wood-destroying fungi in addition to those already mentioned, but a description of them would unduly extend the limits of this article, which is only intended to be an outline. References to selected literature dealing with them will be given later.

In Part III it is proposed to summarise the principal methods of preserving timber against the attacks of fungi.

(*To be continued.*)

CABLE PROBLEMS.

AT the end of his course of lectures on the propagation of currents in telegraph and telephone cables, Prof. J. A. Fleming gave his students a final set of questions, the solutions of which exemplify the more important calculations which have to be performed in dealing with problems of cable transmission. The full solutions of these questions which we give below have been placed at our disposal by Mr. G. F. Odell, B.Sc., and will, it is believed, be of considerable use to those young engineers who are entering upon the study of the higher theory of telegraphy and telephony. The simplifications which the use of complex quantities and hyperbolic functions render possible in dealing with transmission problems are very considerable, and we strongly advise students to familiarise themselves with these comparatively new mathematical methods. Unfortunately information on these special applications of hyperbolic functions is not very accessible, and it is therefore to be hoped that the University of London will publish with as little delay as possible the course of lectures on "The Application of Hyperbolic Functions to Electrical Engineering Problems" recently delivered at the Institution of Electrical Engineers by Dr. Kennelly. These admirable lectures were greatly appreciated by all who had the privilege of hearing them. They are of the greatest interest and importance to telegraph and telephone engineers, and their appearance in book form will be eagerly looked forward to. In fact, as Prof. Silvanus Thompson happily put it at the end of the course, "Great is the hyperbolic function and Dr. Kennelly is its prophet." H. H.

THE PROPAGATION OF ELECTRIC CURRENTS IN TELEPHONE AND TELEGRAPH CABLES.

Examination Paper.

I. Plot, as lines radiating from any origin, the vectors:

$$\operatorname{Cosh}(0{\cdot}5 + j\,0{\cdot}8),\ \sinh(0{\cdot}5 + j\,0{\cdot}8),\ \sqrt{\coth(0{\cdot}5 + j\,0{\cdot}8)}.$$

$0{\cdot}8$ radians $= 45{\cdot}84^\circ$, $0{\cdot}5$ radians $= 28{\cdot}65^\circ$.

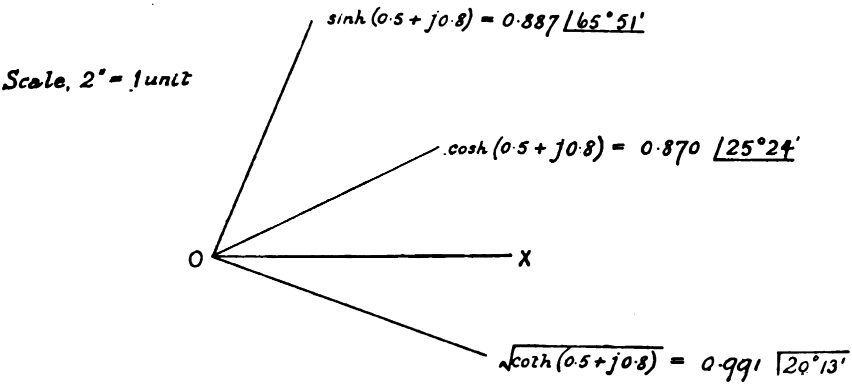
$$\begin{aligned}
\operatorname{Cosh}(0{\cdot}5 + j\,0{\cdot}8) &= \cosh(0{\cdot}5)\cos(0{\cdot}8) + j\sinh(0{\cdot}5)\sin(0{\cdot}8)\\
&= 1{\cdot}128 \times 0{\cdot}697 + j\,0{\cdot}521 \times 0{\cdot}717\\
&= 0{\cdot}786 + 0{\cdot}374\,j.\\
\text{Size of the vector} &= \sqrt{(0{\cdot}786)^2 + (0{\cdot}374)^2}\\
&= 0{\cdot}870.\\
\text{Angle} &= \tan^{-1}\frac{0{\cdot}374}{0{\cdot}786} = 25^\circ\,24',
\end{aligned}$$

$$\therefore\ \cosh(0{\cdot}5 + j\,0{\cdot}8) = 0{\cdot}870\ \underline{|\,25^\circ\,24'}.$$

Similarly $\sinh(0{\cdot}5 + j\,0{\cdot}8) = \sinh(0{\cdot}5)\cos(0{\cdot}8) + j\cosh(0{\cdot}5)\sin\ 0{\cdot}8).$

$$\begin{aligned}
&= 0{\cdot}363 + 0{\cdot}809\,j.\\
&= 0{\cdot}887\ \underline{|\,65^\circ\,51'}.\\
\operatorname{Coth}(0{\cdot}5 + j\,0{\cdot}8) &= \frac{\cosh(0{\cdot}5 + j\,0{\cdot}8)}{\sinh(0{\cdot}5 + j\,0{\cdot}8)}.\\
&= \frac{0{\cdot}870}{0{\cdot}887}\ \Big|\ \underline{25^\circ\,24'} - \underline{65^\circ\,51'}\\
&= 0{\cdot}982\ \overline{|\,40^\circ\,27'}.
\end{aligned}$$

$$\begin{aligned}
\therefore\ \sqrt{\coth(0{\cdot}5 + j\,0{\cdot}8)} &= \sqrt{0{\cdot}982}\ \Big|\overline{\frac{40^\circ\,27'}{2}}\\
&= 0{\cdot}991\ \overline{|\,20^\circ\,13'}\\
&= 0{\cdot}991\cos(-20^\circ\,13') + 0{\cdot}991\sin(-20^\circ\,13').\\
&= 0{\cdot}930 - 0{\cdot}343\,j.
\end{aligned}$$


sinh (0·5 + j0·8) = 0·887 |65°51'
Scale, 2" = 1 unit
cosh (0·5 + j0·8) = 0·870 |25°24'
O
X
√coth (0·5 + j0·8) = 0·991 |20°13'

I.—VECTORIAL DIAGRAM (PROBLEM I).

II. If a length of 40 miles of standard cable (88 ohms. 0·001 henry, and 0·054 mfd. per loop mile) has an alternating E.M.F, of 5 volts, and frequency $\frac{5000}{2\pi}$ applied to one end; calculate the potential difference at the receiving end, when this end is insulated, and the current, if short-circuited.

With the receiving end open, the potential difference at that end, V_2

$$= V_1 \operatorname{sech} P\,l,$$

where V_1 is the potential difference at the sending end, P is the propagation constant, and l the length of the cable.

With the receiving end short-circuited, the current at that end, $I_2 = \frac{V_1}{Z_0} \operatorname{cosech} P\,l$,

where Z_0 is the initial sending end impedance.

Let R, L, K, C, be the resistance, inductance, leakance, and capacity, respectively, of a loop-mile of the cable, and let p be $2\pi f$ where f is the frequency.

$$\text{Then } P = \sqrt{(R + j\,p\,l)\,(K + j\,p\,C)}$$
$$= \alpha + j\,\beta,$$

where α is the attenuation constant and β the wave-length constant.

$$\text{Then } \alpha = \sqrt{\tfrac{1}{2}\,\{p\,C\,\sqrt{R^2 + p^2 L^2} - p^2\,L\,C\}}.$$

From the given values of R, L, and C (K being negligible),

$$\alpha = 0{\cdot}1059.$$

$$\beta = \sqrt{\tfrac{1}{2}\,\{p\,C\,\sqrt{R^2 + p^2 L^2} + p^2\,L\,C\}}$$
$$= 0{\cdot}1121.$$

$$\therefore\ P = 0{\cdot}1059 + 0{\cdot}1121\,j.$$

Now $l = 40$ miles,

$$\therefore\ P\,l = 4{\cdot}236 + 4{\cdot}484\,j.$$

$$\cosh P\,l = \cosh 4{\cdot}236 \cos 4{\cdot}484 + j \sinh 4{\cdot}236 \sin 4{\cdot}484.$$
$= -\,7{\cdot}77 - 33{\cdot}2\,j$ (remembering that $4{\cdot}236$ and $4{\cdot}484$ are in radians)
$$= 34{\cdot}09\ \underline{|\,256^\circ\ 50'}.$$

It will be noticed that the angle ($256^\circ\ 50'$) must be in the third quadrant, because both constituents of $\cosh P\,l$ are negative.

Similarly, $\sinh P l = \sinh 4{\cdot}236 \cos 4{\cdot}484 + j \cosh 4{\cdot}236 \sin 4{\cdot}484$
$$= -\,7{\cdot}73 - 33{\cdot}4\,j$$
$$= 34{\cdot}29\ \underline{|\,256^\circ\ 59'}.$$
$$Z_0 = \sqrt{\frac{R + j\,p\,L}{K + j\,p\,C}}.$$
Now $R + j\,p\,L = 88 + 5j = 88{\cdot}1\ \underline{|\,3^\circ\ 15'}$.
$K + j\,p\,C = 0 + 2{\cdot}7 \times 10^{-4} j = 2{\cdot}7 \times 10^{-4}\ \underline{|\,90^\circ}$,
$$\therefore Z_0 = \sqrt{\frac{88{\cdot}1}{2{\cdot}7 \times 10^{-4}}}\ \underline{\left|\,\frac{3^\circ\ 15' - 90^\circ}{2}\right.}$$
$$= 572\ \overline{|\,43^\circ\ 22'}.$$
$$V_2 = V_1 \operatorname{sech} P\,l = \frac{V_1}{\cosh P\,l}.$$
$V_1 = 5$ volts, $\cosh P\,l = 34{\cdot}09\ \underline{|\,256^\circ\ 50'}$.
$\therefore V_2$ in magnitude
$$= \frac{5}{34{\cdot}09}$$
$= 0{\cdot}147$ volts.
$$I_2 = \frac{V_1}{Z_0} \operatorname{cosech} P\,l$$
$= $ (in magnitude) $\dfrac{5}{572 \times 34{\cdot}29}$ amperes
$= 0{\cdot}255$ milliamperes.

III. Taking the above cable, let a telephone receiver be placed at the receiving end, having an impedance of $1275\ \underline{|\,63^\circ\ 48'}$ vector ohms. Calculate the current through the telephone for the same sending voltage and frequency as in Question II.

In this case, the current at the receiving end, I_{2r}

$$= \frac{V_1}{\sqrt{Z_0^2 - Z_r^2}} \operatorname{cosech}(P\,l + \gamma)$$

where Z_r is the receiving instrument impedance, and
$$\tanh \gamma = \frac{Z_r}{Z_0}.$$

$$
\begin{aligned}
\text{Now } Z_0 &= 572\ |\overline{43^\circ\ 22'} \text{ (as in Question II).}\\
Z_r &= 1275\ \underline{|\,63^\circ\ 48'}.\\
\text{whence } Z_0^2 - Z_r^2 &= 10^6\,(1{\cdot}01 - 1{\cdot}61\,j).\\
&= 1{\cdot}90 \times 10^6\ |\overline{57^\circ\ 56'}.\\
\text{and } \sqrt{Z_0^2 - Z_r^2} &= 1378\ |\ 28^\circ\ 58'.\\
\text{Sinh } \gamma &= \frac{Z_r}{\sqrt{Z_0^2 - Z_r^2}} = \frac{1275\ |\ 63^\circ\ 48'}{1378\ |\ 28^\circ\ 58'}\\
&= 0{\cdot}926\ |\ 92^\circ\ 46'.\\
\text{Similarly cosh } \gamma &= 0{\cdot}415\ |\overline{14^\circ\ 24'}.\\
\text{Sinh } P\,l &= 34{\cdot}29\ \underline{|\,256^\circ\ 59'}\\
\text{and cosh } P\,l &= 34{\cdot}09\ |\ 256^\circ\ 50' \text{ (as in Question II).}
\end{aligned}
$$

Hence $\sinh\,(P\,l + \gamma) = \sinh P\,l \cosh \gamma + \cosh P\,l \sinh \gamma$

$= 24{\cdot}47 - 18{\cdot}30\,j$, the size of which is $\sqrt{(24{\cdot}47)^2 + (18{\cdot}30)^2} = 30{\cdot}6$.

$$
\begin{aligned}
\therefore\ I_2 \text{ (in magnitude)} &= \frac{5}{1378 \times 30{\cdot}6} \text{ amperes}\\
&= 0{\cdot}1187 \text{ milliamperes.}
\end{aligned}
$$

IV. Taking 40 miles of the above cable, let it be loaded at 2-mile intervals with Pupin coils, each of effective resistance 10 ohms and inductance 0·2 henry. Calculate the attenuation constants for the unloaded and loaded 40-mile lengths.

For the unloaded cable the attenuation constant has already been determined in Question II, and has the value $a = 0{\cdot}1059$.

In the case of the loaded cable, consider first the inductance to be uniformly distributed. Then for the constants per loop-mile, the figures are—

$R = 88 + 5 = 93$ ohms. $L = {\cdot}001 + 0{\cdot}1 = 0{\cdot}101$ henry.
$C = 0{\cdot}54 \times 10^{-6}$ mfd. $p = 5000$.

If a^1 is the new attenuation constant and β^1 the new wave-length constant—

$$
\begin{aligned}
a^1 &= \sqrt{\tfrac{1}{2}\,\{p\,C\sqrt{R^2 + p^2\,L^2} - p^2\,L\,C\}}\\
&= 0{\cdot}033.\\
\beta^1 &= 0{\cdot}371.
\end{aligned}
$$

As $p\ C\sqrt{R^2 + p^2\,L^2}$ is little greater than $p^2\,L\,C$ it is not possible to determine more than two significant figures in the value of a^1.

$$
\begin{aligned}
\text{The wave-length } \lambda &= \frac{2\,\pi}{\beta} = \frac{2\,\pi}{0{\cdot}371}\\
&= 17 \text{ miles.}
\end{aligned}
$$

Since the coils are spaced at distances of 2 miles there are more than 8 coils per wave-length, and therefore the error in the value of

a^1, made by assuming the inductance to be uniformly distributed, is less than 1 per cent.

By the introduction of the loading coils, then, the attenuation constant is reduced from 0·106 to 0·033.

V. Given a submarine cable 1000 miles long, having resistance 3 ohms and capacity $\frac{1}{3}$ mfd. per nautical mile, worked without terminal condensers. Assume a letter *s* sent, uncurbed, with 20 volts impressed E.M.F., each dot and each space being 0·1 sec. long. Predetermine the curve which would be drawn by the pen of the syphon recorder at the receiving end.

For the conditions obtaining in a submarine telegraph cable the self-induction is negligible, and the general formula for the current at the receiving end may be expressed by the formula—

$I_r = \frac{2V}{Rl} F(ut)$, where V is the applied voltage, R the resistance per mile, and l the length in miles. $F(ut)$ is a function depending on the signal transmitted. In the case of a dot signal formed by the depression of a key for a time T, $F(ut)$ has the value $f(ut) - f(\overline{ut - T})$. In this expression $u = \frac{\pi^2}{R_0 C_0}$ where C_0 and R_0 are respectively the total capacity and resistance of the cable, and if θ be written for e^{-ut}, $f(ut) = \frac{1}{2} - \theta + \theta^4 - \theta^9 + \theta^{16} -$ etc.

Similarly for the letter *s*, $F(ut)$ has the value $f(ut) - f(\overline{ut - T}) + f(\overline{ut - 2T}) - f(\overline{ut - 3T}) + f(\overline{ut - 4T}) - f(\overline{ut - 5T})$.

For the cable under consideration—

$$C_0 = \tfrac{1}{3} \times 1000 \times 10^{-6} = \tfrac{1}{3} \times 10^{-3} \text{ farads.}$$

$$R_0 = 3000 \text{ ohms.}$$

$$\therefore u = \frac{\pi^2}{C_0 R_0} = 9{\cdot}87.$$

$$T = 0{\cdot}1 \text{ second.}$$

By the use of these values, the value of $F(ut)$ and therefore of I_r may be found for various epochs after the beginning of the signal. Intervals of 0·02 sec. up to a total time of 0·70 sec. will be found ample for the delineation of the curve. An example of the calculation is given here for the value of $t = 0{\cdot}06$ sec.

$$t = 0{\cdot}06 \text{ second.} \quad \therefore ut = 0{\cdot}5922 \text{ sec.}$$

$$\theta = e^{-ut}$$

$$= e^{-0{\cdot}5922}$$

$$= 0{\cdot}5532.$$

$$\text{Whence } \theta^4 = 0{\cdot}0937.$$

$$\theta^9 = 0{\cdot}0049.$$

$$\theta^{16} = 0{\cdot}0001.$$

$$f(ut) = \tfrac{1}{2} - \theta + \theta^4 - \theta^9 + \text{etc.}$$

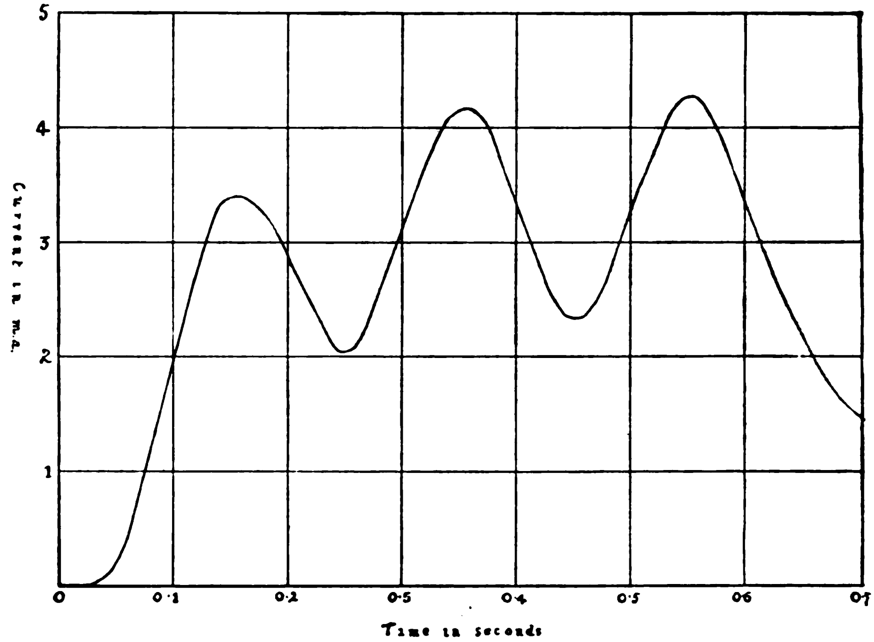
$$= \tfrac{1}{2} - (0{\cdot}5532 + 0{\cdot}0049) + (0{\cdot}0937 + 0{\cdot}0001).$$

$$= \tfrac{1}{2} - 0{\cdot}5581 + 0{\cdot}0938.$$
$$= 0{\cdot}0357.$$

Since the duration of a dot is 0·10 sec. this term is the only one involved, and ∴ $F\ (u\,t)$ is 0·0357. Similarly the whole of column 1 is filled up; columns 2 to 6 are similar, but there is a time lag of 0·10 sec. between succeeding columns. Columns 7 and 8 give respectively the positive and negative constituents of $F\ (u\,t)$ and then $F\ (u\,t)$ is obtained by subtracting column 8 from column 7.

$$I_r = \frac{2\,V}{R\,l}\,F\ (u\,t) = \frac{2 \times 20}{3 \times 1000}\,F\ (u\,t) \text{ amperes.}$$
$$= {\cdot}0133\,F\ (u\,t) \text{ amperes.}$$
$$= 13{\cdot}3\,F\ (u\,t) \text{ milliamperes.}$$

0.	1.	2.	3.	4.	5.	6.	7.	8.	$F\ (u\,t)$.	Ir.
t.	$f\ (u\,t)$.	$f\ (u\,t - T)$.	$f(\overline{u\,t - 2T})$.	$f(u\,t - 3T)$.	$f(\overline{u\,t - 4T})$.	$f(\overline{u\,t - 5T})$.	1 + 3 + 5.	2 + 4 + 6.	7 − 8.	$M.\ a.$
·02	0·0000	—	—	—	—	—	0·0000	—	0·0000	0·000
·04	0·0051	—	—	—	—	—	0·0051	—	0·0051	0·068
·06	0·0357	—	—	—	—	—	0·0357	—	0·0357	0·480
·08	0·0879	—	—	—	—	—	0·0879	—	0·0879	1·17
·10	0·1475	—	—	—	—	—	0·1475	—	0·1475	1·97
·12	0·2032	0·0000	—	—	—	—	0·2032	0·0000	0·2032	2·69
·14	0·2533	0·0051	—	—	—	—	0·2533	0·0051	0·2482	3·31
·16	0·2960	0·0357	—	—	—	—	0·2960	0·0357	0·2603	3·46
·18	0·3319	0·0879	—	—	—	—	0·3319	0·0879	0·2440	3·25
·20	0·3618	0·1475	—	—	—	—	0·3618	0·1475	0·2143	2·86
·22	0·3862	0·2032	0·0000	—	—	—	0·3862	0·2032	0·1830	2·43
·24	0·4067	0·2533	0·0051	—	—	—	0·4118	0·2533	0·1585	2·11
·26	0·4234	0·2960	0·0357	—	—	—	0·4591	0·2960	0·1631	2·17
·28	0·4371	0·3319	0·0879	—	—	—	0·5250	0·3319	0·1931	2·58
·30	0·4484	0·3618	0·1475	—	—	—	0·5959	0·3862	0·2341	3·12
·32	0·4576	0·3862	0·2032	0·0000	—	—	0·6608	0·3862	0·2746	3·64
·34	0·4652	0·4067	0·2533	0·0051	—	—	0·7185	0·4118	0·3067	4·09
·36	0·4715	0·4234	0·2960	0·0357	—	—	0·7675	0·4591	0·3084	4·10
·38	0·4766	0·4371	0·3319	0·0879	—	—	0·8085	0·5250	0·2935	3·91
·40	0·4808	0·4484	0·3618	0·1475	—	—	0·8426	0·5959	0·2467	3·29
·42	0·4842	0·4576	0·3862	0·2032	0·0000	—	0·8704	0·6608	0·2096	2·78
·44	0·4871	0·4652	0·4067	0·2533	0·0051	—	0·8989	0·7185	0·1804	2·41
·46	0·4894	0·4715	0·4234	0·2960	0·0357	—	0·9485	0·7675	0·1810	2·40
·48	0·4913	0·4766	0·4371	0·3319	0·0879	—	1·0163	0·8085	0·2078	2·76
·50	0·4928	0·4808	0·4484	0·3618	0·1475	—	1·0887	0·8426	0·2461	3·28
·52	0·4941	0·4842	0·4576	0·3862	0·2032	0·0000	1·1549	0·8704	0·2845	3·77
·54	0·4952	0·4871	0·4652	0·4067	0·2533	0·0051	1·2147	0·8989	0·3158	4·21
·56	0·4960	0·4894	0·4715	0·4234	0·2960	0·0357	1·2635	0·9485	0·3150	4·20
·58	0·4968	0·4913	0·4766	0·4371	0·3319	0·0879	1·3053	1·0163	0·2890	3·86
·60	0·4973	0·4928	0·4808	0·4484	0·3618	0·1475	1·3399	1·0887	0·2512	3·35
·62	0·4978	0·4941	0·4842	0·4576	0·3862	0·2032	1·3682	1·1549	0·2133	2·84
·64	0·4982	0·4952	0·4871	0·4652	0·4067	0·2533	1·3920	1·2147	0·1773	2·36
·66	0·4985	0·4960	0·4894	0·4715	0·4234	0·2960	1·4113	1·2635	0·1478	1·97
·68	0·4988	0·4968	0·4913	0·4766	0·4371	0·3319	1·4272	1·3053	0·1219	1·62
·70	0·4990	0·4973	0·4928	0·4808	0·4484	0·3618	1·4402	1·3399	0·1103	1·48



2.—PREDETERMINATION OF CURVE FOR LETTER *s*, DRAWN BY SYPHON RECORDER AT END OF CABLE 1000 MILES LONG (PROBLEM V).

VI. If a power transmission line 50 miles long consists of a pair of No. 4 S.W.G. copper wires each 5·9 mm. diameter placed one metre apart, and if these lines are carried on poles 40 ft. above the ground, calculate the capacity, inductance, and impedance of this line for currents of a frequency of 25 periods per second, assuming the copper resistance to be 2 ohms per loop mile.

The capacity of two parallel wires of diameter d and at a distance apart D is $\dfrac{0{\cdot}0194}{\log_{10}\dfrac{2\,D}{d}}$ microfarads per mile.

In this case $D = 1000$ mm.

$$d = 5{\cdot}9 \text{ mm.}$$

$$\frac{2\,D}{d} = 339.$$

$$\text{and } \log_{10}\frac{2\,D}{d} = 2{\cdot}53.$$

$$\therefore \text{ capacity} = \frac{0{\cdot}0194}{2{\cdot}53} \text{ microfarads per mile.}$$

$$\text{Total capacity} = \frac{50 \times 0{\cdot}0194}{2{\cdot}53}$$

$$= 0{\cdot}383 \text{ microfarads.}$$

The inductance in microhenries, l being the length of the line in cms. $= \frac{4\,l}{1000}\left\{2{\cdot}3026 \log_{10}\frac{2\,D}{d}\right\}$.

$$l = 50 \times 1760 \times 36 \times 2{\cdot}54 \text{ cm.}$$

Whence inductance = 0·1875 henry.

The initial sending end impedance is $\frac{\sqrt{R + j\,p\,L}}{\sqrt{K + j\,p\,C}}$, where the symbols refer to the whole length. R = 100 ohms, $L = 0{\cdot}1875$ henry, $K = 0$, $C = 0{\cdot}383 \times 10^{-6}$ farad, $p = 2\,\pi \times 25 = 50\,\pi$.

$$\begin{aligned} R + j\,p\,L &= 100 + 50\,\pi \times 0{\cdot}1875\,j. \\ &= 100 + 29{\cdot}4\,j. \\ &= 104{\cdot}2 \mid 16^\circ\ 23'. \\ K + j\,p\,C &= 50\,\pi \times 0{\cdot}383 \times 10^{-6}\,j. \\ &= 6{\cdot}02 \times 10^{-5}\,j. \\ &= 6{\cdot}02 \times 10^{5} \mid 90^\circ. \end{aligned}$$

$$\therefore \frac{R + j\,p\,L}{K + j\,p\,C} = 173 \times 10^{4}\ \overline{|\,73^\circ\ 37'},$$

and $\frac{\sqrt{R + j\,p\,L}}{\sqrt{K + j\,p\,C}} = 1315\ \overline{|\,36^\circ\ 49'}$, which is the impedance in vector ohms.

G. F. O.

ENAMELLED WIRE.

By W. B. Smith, A.I.E.E.

In response to an invitation received from the Directors of Messrs. Connolly Bros., Limited, Insulated Wire and Cable Manufacturers, Blackley, Manchester, the members of the North-Western Centre visited the Blackley Vale Mills on February 6th.

As one of the specialities of this Company is the manufacture of enamelled wire, a few notes on the preparation and uses of this material may be of interest to members who may not have the opportunity of visiting the works.

Many attempts have been made to produce an enamel-coated wire for electrical purposes, but they have failed either entirely or in some important and necessary qualification.

Much was expected from the use of a compound known as cellulose tetra-acetate, which was introduced a few years ago, but its poor resistance to heat and weak alkaline solutions was sufficient to prevent its use for many purposes.

It may be well at this point to explain the difference between vitreous enamels and lacquers, or varnishes, which are sometimes described as enamels. The first-mentioned consist of a vitreous glaze fused to a metallic surface; the glaze usually consists of easily fusible salts, such as the silicates or borates of sodium, potassium and lead, to which various metallic oxides are added to impart colour. After coating, the article is exposed to a moderate heat in a furnace, when the vitreous substance soon becomes sufficiently fluid to spread itself over the metal surface, to which it closely adheres. If the glaze is merely cemented to the metal surface, without any trace of fusion, it is not true enamel. Enamels as described in the foregoing are not suitable for coating wires for electrical purposes, as they are not sufficiently flexible, and are poor insulators.

From time immemorial the preparation and use of varnishes or lacquers—frequently described as enamels—for application to metallic surfaces has been based upon the principle of drying and hardening by oxidation of linseed, or other vegetable oils, either alone, or in combination with resins, gums, pitches, and mineral or other colouring matter, and with or without the use of a rapidly drying solvent, such as spirits or turpentine, benzole, naphtha, etc., the oil being specially treated with a view to partial oxidation in order to shorten the time required for hardening. Sometimes the hardening is accomplished by simple exposure to air, sometimes by the assistance of heat. All varnishes and lacquers or enamels as described above have the undesirable characteristic that the oxidisation does not cease when the desired degree of hardness is obtained, but continues to develop indefinitely until the coating is decomposed, becomes brittle, and breaks up. This process of disintegration is undoubtedly accelerated by electrolysis.

The patent enamel which is made by Messrs. Connolly Bros. occupies a position midway between the vitreous enamels and the lacquers or varnishes or the enamels described in the foregoing. It is fixed at a much higher heat, and is perfectly adherent to the wire. It is produced by a special treatment of hydrocarbons containing a high percentage of carbons. This treatment results in a peculiar change or polymerisation—something akin to the change that takes place in the vulcanisation of india-rubber, or, to use a more familiar example, in the boiling of an egg, which, while not altering the chemical constituents of the substance, alters its physical characteristics to a remarkable degree—and when this change has once been brought about the enamel becomes unalterable in its physical properties.

This enamel is not melted by heat, a temporary exposure at 600° to 700° F. does no harm, a heat of 400° F. for several hours or a permanent heat of 300° F. does not alter it. It is also proof against the most powerful oxidising agents, such as peroxide of hydrogen, chromic acid, permanganate of potash, and hypochlorite of sodium.

Weak acids, even on boiling, do not injure the enamel, and it withstands the action of alkalies and ammonia.

It is evident, therefore, that atmospheric conditions can in no way cause injury. On this account large quantities of this wire are being used for the construction of the antennæ in wireless telegraph installations on board war-vessels and steamships, where it has been found that other classes of wire quickly deteriorate and become useless owing to the deleterious action of the gases and fumes discharged from the funnels.

Wire coated with this enamel is also proof against electrolysis.

The following table shows a comparison between Connolly's enamel and india-rubber and gutta-percha.

	Insulation resistance, megohms per c.cm.	Inductive capacity, mfs. per c.cm.
Connolly's enamel . .	$13{\cdot}75 \times 10^{9}$	$3{\cdot}29 \times 10^{7}$
India-rubber . . .	$7{\cdot}58 \times 10^{9}$	$2{\cdot}93 \times 10^{7}$
Gutta-percha . . .	$3{\cdot}9 \times 10^{8}$	$3{\cdot}71 \times 10^{7}$

Dielectric strength Connolly's enamel = 1000 volts A.C. for each $\frac{1}{1000}$th of an inch thickness.

The enamel is flexible, and wire covered with it can be employed freely for winding coils used in all classes of electro-magnetic apparatus.

In addition to copper, wires of bronze, brass, iron, steel, German silver, eureka and manganin have been successfully coated, but wires of tin or lead, or wire covered with either tin, lead, or zinc cannot be enamelled by this process because the high temperature at which the enamel is fixed is above the melting-point of the metals referred to.

On account of its small space-factor enamelled wire is specially useful in winding the coils of telegraph or telephone instruments. Four coatings of the enamel are used on wires intended for this purpose, and the thickness of coating, that is, the total increase in over-all diameter, does not exceed 1 mil for sizes up to 30 and 2 mils for sizes up to 18.

The jointing of enamel wire demands special treatment. The joint should be silver soldered, brazed or electrically welded. Ordinary solder would not do, as it would not stand the heat required to harden the enamel. After soldering, the enamelling solution is thickly applied to the joint. The enamel has then to be hardened. A special stove is supplied for this purpose consisting essentially of a tube split in two halves; these are clamped over the joint, the wire resting on small mica bridges provided inside the tube. Heat is then applied from any available source, such as a Bunsen burner, blow-lamp, or Swedish torch. The heat should be applied for about three minutes, and the joint allowed to cool before handling. The temperature required for fixing the enamel is about 600° F. The process can be repeated for two or three coatings.

The following extract from the 'Elektrotechnische Zeitschrift,' of August 11th, 1910, on "Enamelled Wire Coils" is of great interest:

"In the preparation of coils or bobbins with enamelled wire the same precautions are to be observed as with bobbins wound with other insulated wires. No kinks must be allowed to pass without being adjusted. The layers must be wound right up to the flanges in order that the last turn shall not come in contact with the turns of any layers underneath. The tension with which the wire is put on should be even, and not too strong, especially in the winding of the last layers. And lastly, bobbins with too deep a thickness of layers should be avoided. Only the last precaution mentioned is really of any great importance when bobbins which contain a large number of layers are likely to be under the influence of a heavy current; the inner layers are warmed up to a much higher degree than the outer ones, and in consequence expand very much more than the latter. In creating the necessary room for expansion they press very strongly upon the insulation. Seeing that in the case of enamelled wire the insulation is only a few hundredths of a millimetre thick, the volume enclosed in the coil does not contain much material of a compressible nature, so that the inner layers have not much freedom for expansion. It is necessary, therefore, to bear in mind as a safe rule that with coils which are heavily loaded and where the temperature may rise more than 30° C. above that of the surrounding air, the depth of the coil should be kept as small as possible, and in any case should not be more than half the total radius of the coil. In the case of coils that are not likely to be overheated there is no necessity to take any particular care of the depth of the coil or the manner of winding on."

For the substance of these notes I am indebted to Messrs. Connolly Bros.

DESICCATORS.

By J. G. Hines.

At a recent meeting of the Institution of Post Office Electrical Engineers, the Engineer-in-Chief stated that, excluding distribution cable, the length of paper-core cable already in use exceeded 2300 miles, and that this mileage was being steadily increased.

In the type of cable referred to the insulation resistance depends entirely, and the electrostatic capacity to some extent, upon the hygrometric state of the air in the cable. The subject of desiccation is therefore one of considerable and increasing importance.

In the Department's specifications for paper-core cable a minimum insulation resistance of 5000 megohms per mile is specified, but, owing to the method of drying adopted at the manufacturers' works, the insulation resistance obtained is generally greatly above the minimum.

The method of drying paper-core cables at cable factories differs considerably from that employed to dry cables *in situ*, and is undoubtedly more efficient, but unfortunately it is not practicable to apply the factory method to cables which are in conduits.

Although there are differences of detail, the principle of drying cables is the same at all factories, and will be briefly described.

After a cable has received the outer layer of wires it is wound upon an iron drum and placed in an oven heated by coils of steam pipes. The door of this oven is sealed to prevent the entrance of damp air. The air in the oven is then withdrawn by means of air pumps, and partly replaced by air which has first been dried by passing it through cylinders containing quicklime, calcium chloride, and cotton-wool in the order named. The flow of air is restricted so that a vacuum of about 21 in. of mercury is maintained in the oven.

The conditions inside the oven are thus favourable to the rapid evaporation of any water that may be in the cable, as the atmospheric pressure is very low, the temperature of the water and air is high, and the air is dry and is constantly being renewed.

The importance of the provision of the air inlet was not at first recognised, and a higher vacuum was then obtained, but it was found that, in the absence of air, heat was not readily conducted from the sides of the oven to the cable, and fresh layers of dry air were not brought into contact with the damp cable.

Occasionally cables are dried by the use of heat alone, but the operation takes longer, and is fraught with a certain amount of danger, as the paper is rendered brittle if overheated.

On account of the rapidity with which evaporation takes place at very low pressures, attempts have been made by the writer to apply a modification of the vacuum method to cables *in situ*. Of course it is not often possible to heat a cable throughout its whole length, but in one case it was possible to warm a considerable portion of a length and to admit warm, dry air at the inlet which was provided. Unfortunately there were other inlets which were not intentionally provided, and it is feared that while it is necessary to use cable-heads, pot-heads, etc., vacuum drying cannot be applied advantageously.

Up to the present the method generally adopted by the Department has been to pump compressed air into the cables through a drying agent.

The first type of desiccator consisted of a portable three-throw pump driven by a crank turned by two men, and it is safe to say that no one who has watched the machine in operation has marvelled at any lack of enthusiasm on the part of the operators. Excellent work was, however, accomplished, and is still being done by means of these hand-driven machines. The air, after compression, passes through four cast-iron cylinders containing calcium chloride, and then through a small cylinder filled with cotton-wool which acts as a filter, and prevents oil and dust entering the cable. With this machine about 3 ft. of free air per minute can be compressed to 10 lb. pressure per square inch.

It was soon realised that the rapid extension of the underground system of cables demanded a corresponding increase in facilities for desiccating, and naturally it was sought to improve the apparatus for drying the air and to effect economy by substituting machine power for manual labour.

At the London telephone exchanges and in some of the large provincial post offices air compressors driven by electric motors were installed. The arrangement of the desiccating cylinders was practically the same as that in the portable desiccators, but as the compressors delivered from 10 to 60 cubic feet of free air per minute compressed to 30 lb. pressure per square inch, the cylinders were necessarily made larger and stronger.

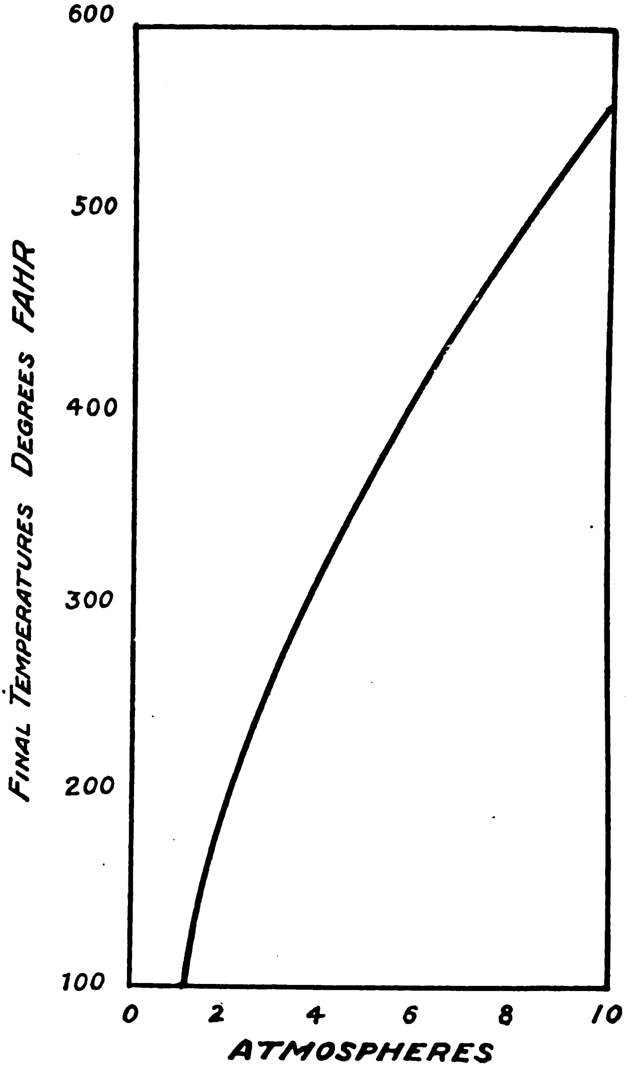
The increase in the working pressure from 10 lb. to 30 lb. per square inch resulted in an immediate increase of efficiency, since the effect of compressing moisture-laden air is similar to that obtained by compressing a saturated sponge. The foregoing statement is only true, however, if the air is compressed isothermally, *i.e.* without increase of temperature.

Table 1 shows for a wide range of pressures the amount of water in pounds that may condense from one cubic foot of compressed saturated air if the compression is isothermal.

TABLE 1.

Compressed at temperature.	To 45 pounds (4 volumes).	To 75 pounds (6 volumes).	To 105 pounds (8 volumes).	To 210 pounds (15 volumes).	To 435 pounds (30 volumes).
32° F.	·000912	·00152	·002128	·004256	·008816
42° F.	·001320	·00220	·003080	·006160	·012760
52° F.	·001881	·003135	·004389	·008778	·018188
62° F.	·002643	·004405	·006167	·012334	·025549
72° F.	·003663	·006105	·008547	·017094	.035309
82° F.	·005001	·008335	·011669	·023338	·048343
92° F.	·006750	·011250	·015750	·031500	·065250

It is practically impossible under ordinary conditions to compress air isothermally. When air is compressed its temperature is raised, the final temperature depending upon the initial temperature, the final pressure and the amount of heat abstracted during compression. If it were possible to compress air adiabatically, *i. e.* to retain all the



I.—CURVE SHOWING VARIATION OF TEMPERATURE WITH PRESSURE.

heat of compression, the temperature would rise rapidly as shown in I.

Truly adiabatic conditions also are never met with in practice, as much of the heat is conducted or radiated away, and what is obtained is something between the ideal isothermal and adiabatic conditions. Some provision is made for cooling the air, but the heat which remains is sufficient to raise the temperature of the air leaving the compressor much above the temperature of the atmosphere. That this heat is undesirable is clearly shown by the following table, which gives the weight of vapour in one cubic foot of air when saturated between the temperatures of 32° F. and 94° F.

TABLE 2.

Temperature of air F.	Weight grains.	Temperature of air F.	Weight grains.	Temperature of air F.	Weight grains.
32°	2·37	56°	5·18	76°	9·60
35°	2·63	58°	5·51	78°	10·19
38°	2·89	60°	5·87	80°	10·81
41°	3·19	62°	6·25	82°	11·47
44°	3·52	64°	6·65	84°	12·17
46°	3·76	66°	7·08	86°	12·91
48°	4·01	68°	7·53	88°	13·68
50°	4·28	70°	8·00	90°	14·50
52°	4·56	72°	8·50	92°	15·33
54°	4·86	74°	9·04	94°	16·22

As a result of the writer's experiments on the effect of cooling compressed air receivers have been fitted between the compressor and the desiccator at most of the large telephone exchanges, and, as might be expected, an appreciable quantity of water and oil is drawn off at the drain cocks of these receivers. The air receiver consists of a simple iron cylinder of large capacity and is not provided with any special cooling arrangement, so that although the temperature of the compressed air is lowered in the receiver it always exceeds the atmospheric temperature. A greater efficiency would be obtained if the compressed air were further cooled by passing it over a system of pipes in which a non-freezing brine circulates. This is the method employed in some refrigerating plants, but it involves the use of another machine to remove the heat taken up by the brine in its passage through the pipes. Cold water might be used instead of brine in the circulating system, but of course it would not be so efficient, although it is found of considerable value in the intercoolers of two- and three-stage compressors. Another method that might be employed consists in allowing some of the partially cooled compressed air to expand around the container and thus to abstract some heat from the walls.

It was at first hoped that it would be possible by means of a desiccator of large capacity fixed at an exchange to maintain the insulation of all cables radiating from that exchange, but unfortunately those hopes have not been realised. A cable may be desiccated from the exchange to the point where the first cable-head is fixed, but if a number of cables radiate from the cable-head the exchange desiccator cannot be relied upon to dry the branching cables.

Experiments were therefore made to determine the most suitable form of portable desiccator for use on cables which could not be dried from an exchange.

An opportunity occurred of using a small portable desiccator with an electric motor driven by current taken from a supply company's mains in the vicinity, and if such a source of electric power were always available further developments would probably have been made in this direction. Unfortunately, however, electric power is not always available where wanted, and it was necessary to consider what other source of power could be used. A petrol motor was ultimately employed, and the particular type selected has proved suitable and reliable.

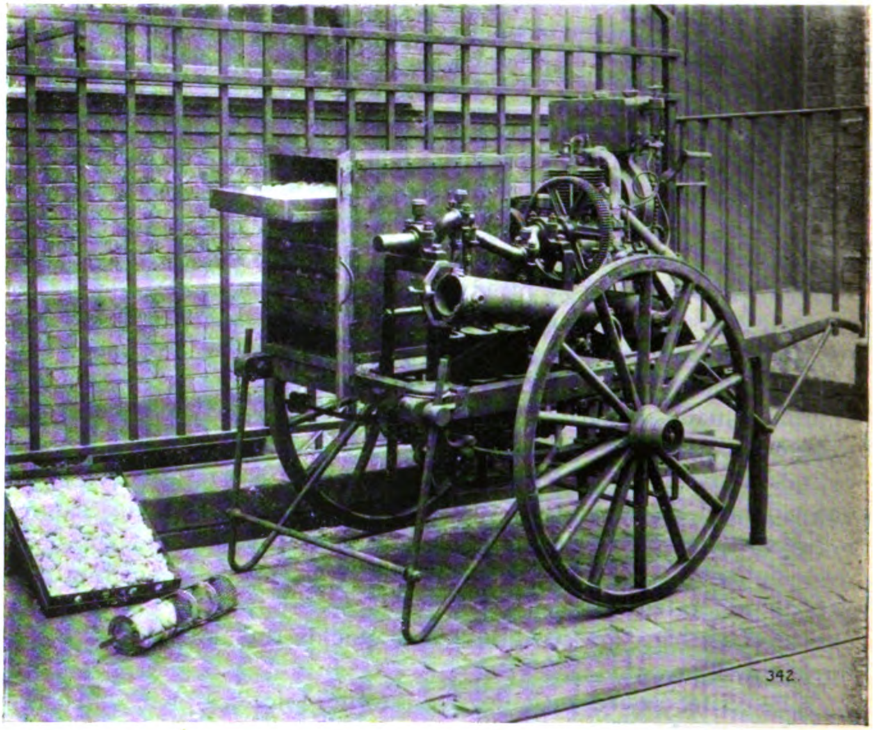
This desiccator was described and illustrated in vol. 1, at p. 123.

In order to obtain the greatest efficiency it is necessary that the air shall pass over a large surface of drying agent. In the stationary desiccators this is achieved by providing an ample number of large cylinders. Transport considerations limit the number and size of the cylinders that can be fitted on the portable desiccators and also prevent the use of a large receiver, so that special attention must be paid to the method of filling the cylinders. Unfortunately a satisfactory means of doing this has not yet been devised. Internal cylinders made of perforated zinc have been tried, but were abandoned because it was found that if they were made a good fit the cylinders became cemented together with crystallised calcium chloride and the separation was difficult, while if the diameter was reduced, undried air passed up the annulus between the zinc and iron cylinders. Similar difficulties have been experienced in the use of perforated circular trays on a central spindle. At present cheese-cloth bags are used, but they quickly rot and fall to pieces during withdrawal.

The writer has recently devised a form of desiccator which comparative tests have shown to be more efficient than those hitherto employed.

In this desiccator the air is dried at atmospheric temperature *before* it is compressed. The water vapour is therefore given up more readily and the heat due to compression is not disadvantageous, as it is applied to air which has previously been dried. Atmospheric air enters at the bottom of a sheet-iron container and then passes over a number of shallow trays arranged in the form of a baffle, being finally drawn from the top of the container into an air-pump. It is there compressed and passed through a filter, in which any oil which may be carried from the compressor is trapped. The filter, which is shown at the bottom of **2**, comprises a number of wire-gauze discs and a wad of cotton-wool. When in use it is inserted in the horizontal cylinder shown at the front of the compressor.

The machine illustrated was fitted up by the General Factory staff for experimental work and does not represent the ultimate form, which will probably resemble the existing motor desiccators. The photograph was taken before the machine was quite finished, and does not show the outlet from the container, while the inlet has been placed in error at the top of the container.



2.—Desiccator Modified to Dry Air Before, instead of After, Compression.

Lengthy comparative tests have been made under various atmospheric conditions between the new form of desiccator and one of the standard type. As a result of five trials with the atmospheric temperature at 60·36° F., the dewpoint figures attained averaged 38·6° F. for the former type and 40·4° F. for the latter.

After further slight modifications had been made in the desiccator a further series of trials was made with the atmospheric temperature at 63·1° F. With the new machine a dewpoint of 11·33° F. was obtained, while with the standard desiccator the lowest dewpoint was 14·33° F. It will be seen that the improvement is very marked.

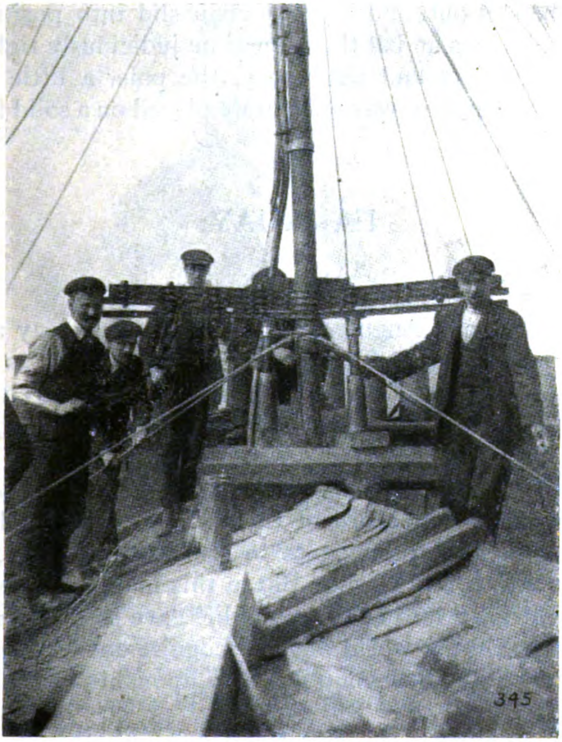
During the second series of trials the atmosphere was much dryer than when the first tests were carried out.

In conclusion, it may be observed that as the container in the new machine has not to be built to withstand pressure, it is lighter than the cast-iron cylinders hitherto used and is also cheaper, while the calcium chloride can be readily inspected and its renewal quickly effected.

REPLACING A POLE CHAIR.

By E. M.

The maintenance of the large number of roof standards in Glasgow sometimes gives rise to quite interesting work. While the usual stay repairs were being carried out in connection with a large terminal pole on a high roof it was discovered that the pole chair had broken and that there was danger of the pole going through the roof. It would have been quite simple to have erected another pole alongside the first and transferred the wires to this while the chair was being replaced, but this would have been a long job, and



"engineering is doing for one dollar what any fool could do for two."

The photograph shows an arrangement whereby a great saving of time was effected. Some old arms were securely clamped to the pole at a height of about two feet and two jacks arranged to stand on a strong wooden structure and bear against them. Four temporary stays were provided. These had proper swivels, and stretched from just below the temporary arms to four diagonally opposite positions on the roof. Thus, by suitably adjusting jacks and stays, the equilibrium of the pole could be made quite independent of the roof immediately below it.

It was at first intended to raise the pole and so insert the new chair, but it was seen that the stays could not be slackened sufficiently. So the pole was raised an inch and enough of it cut off to allow the old chair to be slid out, and the new chair slid into position. Then by lowering the jacks and at the same time judiciously tightening the stays, both permanent and temporary, the pole, a little shortened, but otherwise unharmed, was once more placed on a solid foundation.

FARADAY.

By AND. FRASER.

ON the 25th day of August, 1867, there passed away a man who will not only rank as one of the profoundest thinkers, as one of the most strenuous and indefatigable workers in the search for truth, but as the most brilliant experimentalist that England has ever produced.

There are great men who come into the world and go out of it leaving but a transitory record of their achievements behind them. The world listens for a brief space to their message, and, sooner or later, forgets both it and them. But in this man, whose obscure and unobtrusive entrance into the arena of life gave so little promise of a laurel-crowned exit, the world was to recognise one who was destined to make an indelible impression not only upon his own time, but on all times.

Born in the neighbourhood of London, in the year 1791, the son of a working blacksmith, Michael Faraday commenced life as a newspaper boy, subsequently becoming apprenticed to a bookbinder. Amongst the various books which passed through his hands there was an encyclopedia containing an article on electricity. This article awakened in him the desire for knowledge, and supplied the initial impulse in a career which was henceforth to be devoted to the pursuit of science. At this particular period we find him borrowing a shilling from his brother—a plumber—to enable him to attend one of the lectures at the Royal Institution. Of these lectures he made elaborate notes and sketches, which he had the temerity to send to Sir Humphrey Davy, the greatest chemist of his time, with a request that he might be given some form of employment at the Royal Institution. One may conjecture what the feelings of the great man were when perusing the application of the bookbinder's apprentice! Sir Humphrey advised him to stick to his trade, assuring him that science rewarded her followers but poorly. Nevertheless, Davy found for him a situation as laboratory assistant at twenty-five shillings a week. This was the first stepping-stone in a career which was one day to place Faraday on a level with his distinguished master, and at a later day to raise him even higher.

Michael Faraday, 1791–1867.

At twenty-nine years of age Faraday married, and brought his wife to the Royal Institution, where two rooms had been allocated to him. His salary at this time was £100 a year!

Faraday's first electrcial experiments were made when he was twenty-one years of age. At the age of thirty-two he liquefied chlorine gas, and two years later discovered benzene, that remarkable hydrocarbon which forms the starting-point of one of the great divisions of the chemistry of the carbon compounds. At this time—

"If you had gone to see him in his laboratory, you would have found him wearing a large apron, with just the apparatus he wanted, and no more, arranged before him on the table, and this generally of the simplest kind that would serve his purpose; and then he would begin with those wonderful broad-ended fingers of his, twisting about wires, blowing glass, or working skilfully with corks and cards, and other things, to produce the contrivances he wanted, and all the time balancing himself on one foot, and then on the other, and swinging himself from side to side while he observed what took place." *

In the year 1831 Faraday began the monumental work, known as his 'Electrical Researches,' and in October of the same year he discovered electro-magnetic induction. Sixteen days after the discovery he followed it up by the discovery of magneto-electric induction, and in the following year he announced to the world the laws of electrolysis.

It was just eleven years after Oersted had announced his discovery of the deflection of a magnetic needle by a current flowing in a wire, that Faraday succeeded in obtaining an experimental verification of a belief which his fertile imagination had created. Contrasting the inducing and induced charges in an electrostatic field with this discovery of Oersted's, Faraday asked himself if the magnetic field surrounding the current-carrying wire could produce an induced current in a neighbouring circuit in the same way as an electrified body produces an induced charge in neighbouring conductors. His first experiments gave, to use his own phrase, "no result." This was in 1828. Three and a half years later Faraday writes in his note-book:

"I have had an iron ring made (soft iron) iron round and ⅞ in. thick, and ring 6 in. external diameter. Wound many coils of copper round one half of it, the coils being separated by twine and calico; there were three lengths of wire, each about 24 ft. long, and they could be connected as one length or used as separate lengths. By trials with a trough each was insulated from the other. Will call this side of the ring A. On the other side, but separated by an interval, was wound wire in two pieces, together amounting to about 60 ft. in length, the direction being as with the former coils. This side call B. Charged a battery of ten pairs of plates 4 in. square. Made the coil B side one coil, and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 ft. from wire ring), then connected the ends of one of the pieces on A side with battery; immediately a sensible effect upon the needle. It oscillated, and settled at last in original position. On breaking connection of A side with battery, again a disturbance of the needle."

---

* Dr. J. H. Gladstone, 'Manchester Science Lecture.'

Here lay the proof of his theory, and was at the same time his first experiments in the field of electro-magnetic induction.

The next ten years of Faraday's life were occupied in researches on frictional electricity, specific inductive capacity and the origin of the current in a voltaic cell. At the end of the period his health broke down, and for the next three years he abstained from all scientific work. On resuming his investigations, he discovered diamagnetism, and what he called the " magnetisation of light "—a problem at which he had been working off and on for over ten years. In the year 1855 he brought his twenty-four years of published researches to an end. These comprised thirty papers and contained 3430 paragraphs. In 1865 Faraday resigned all his appointments, and two years later died at Hampton Court at the age of seventy-six.

At the time of his death Faraday had received in all ninety-five titles or honorary distinctions, and was a member of seventy-two learned societies. At a certain period of his life when asked if he would accept a knighthood he declined on the ground that he desired " to remain plain Michael Faraday to the last."

Of Faraday's early childhood little is known; but two incidents occurred then which show at this period even the existence of experimental and philosophic tendencies. He was amusing himself in his father's workshop one day by pitching half-pence into a pot, gradually increasing the distance between himself and the pot until he fell down a hole and would probably have been killed had he not fallen on his father's back. At another time when delivering papers at a house, and while waiting for the servant to answer his knock, he thrust his head through the iron railings, and began to speculate as to which side of the railings he was actually on. Pulling himself back hurriedly he injured his head in a way that left its trace for many years afterwards.

Faraday's affection for his early home was well exemplified in later years when he was giving sittings to the sculptor Noble for his bust. The latter happened to jingle his chisels together at one point, and on looking at Faraday he saw that a far-away look had come into his eyes. " I am afraid you are weary," said Noble. " No, my dear Mr. Noble," said Faraday, putting his hand on the sculptor's shoulder, " but the jingling of your tools took me back to my father's anvil, and I was among old scenes."

Writing on one occasion from Switzerland, where he had gone to recuperate, to his friend and assistant Tyndall, Faraday says he stood for some time looking in at a blacksmith working at his forge and remarks, " I love a smith's shop, my father was a smith." At another time, one wet foggy evening, Faraday, while walking along the pavement, plunged in a brown study, was pestered by a newspaper boy to buy a paper. A policeman, who had been looking on, seized the urchin and was thrusting him roughly aside, when Faraday, taking in the situation, placed his hand on the policeman's arm with the words "Gently, my good man; I, too, was once a newspaper boy."

Dr. Gladstone, speaking of Faraday at Manchester in the year 1872, said, "There was a great reverence which seemed to characterise the man—a reverence not for God only, not for nature only, but for man, for all men, unless he knew them to be bad. It was difficult to take liberties with him. It was strange, too, how in talking with him you felt he was giving you credit for high motives, and for noble aims, while perhaps you felt ashamed of yourself, being aware that your own aims were not as high as those which Faraday was imputing to you. And so the general effect of intercourse with him was that of a moral tonic, and one went away from the good man feeling braced and stronger for the various duties of life."

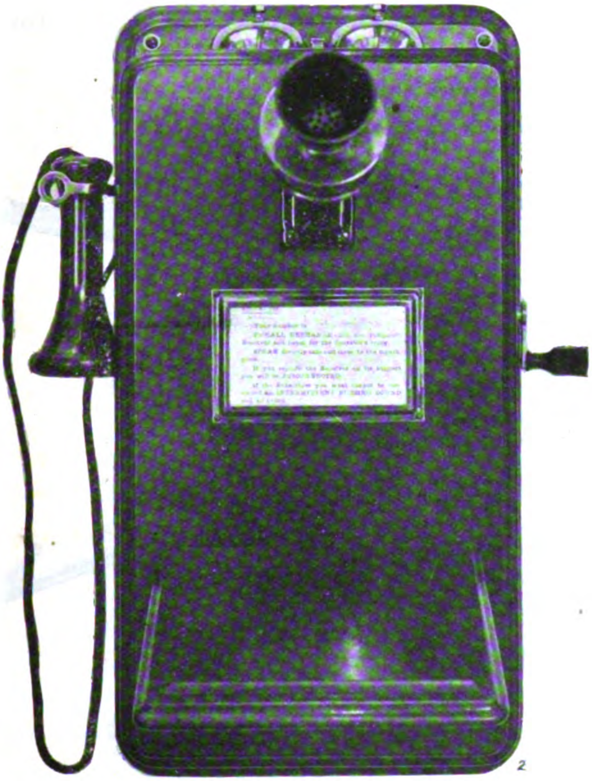
In a mind such as Faraday's, busy analysing the results furnished it by experiments, and combining them into wider generalisations, we may reasonably wonder how the essential nature of electricity or of magnetism presented itself, for his mind must have formed some working conception of it, even though the conception were that of a fluid, and in this connection Dr. Barrett records that one day, while he was damping the oscillations of a magnetic needle by means of a magnet which he was holding at some distance from it, Faraday happened to be passing at the time, and, to quote Dr. Barrett, "he turned to me and said, 'How mysterious is that power you have there; the more I brood over it the less I seem to know.' Yet I suppose," continues Barrett, "no one in this world knew more of it than he."

No one seeing Faraday in the days of his decreptitude, when his memory had become a complete blank, would have believed that this man was one of our greatest masters—our "Prince of Experimentalists"—who sought after the truth for its own sake and not for the rewards which it might bring; who combined in his own personality a moral uprightness and an unflagging perseverance towards the goal to which his energies were directed which is probably without its equal. But Faraday is gone; and although England has had many celebrated sons, who have made her name illustrious wherever the light of science has spread, yet amongst them all, it may surely be said, there is none of whom she is prouder, or who lies nearer to her heart to-day, than the humble blacksmith's son, Michael Faraday.

NEW IDEAS.*

A NEW WALL TELEPHONE.

A NEW type of wall telephone, suitable for use on C.B.S. and magneto systems, has been introduced recently which combines two very necessary features in subscribers' telephone sets, viz. simplicity of design and reliability of working parts, in a very effective manner. It has been realised for some time that although telephone sets with highly ornamental woodwork look well when first supplied, they afterwards entail very heavy maintenance costs owing to the risk of damage to these comparatively delicate parts and the consequent high repair costs, and the policy now is to avoid elaboration where possible.



I.—NEW WALL TELEPHONE.

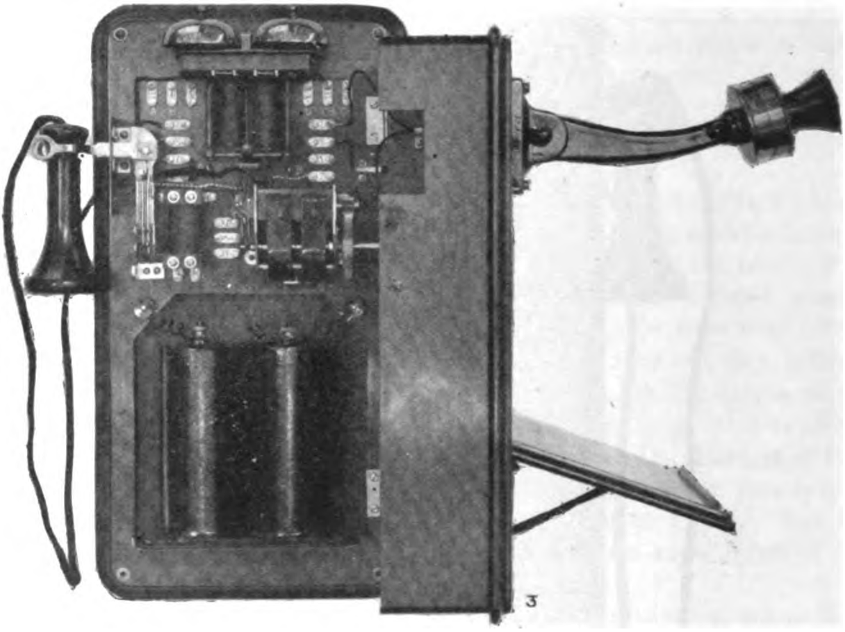
It will be admitted, after an inspection of I, that the design is

* By the kind permission of the Engineer-in-Chief and with the concurrence of the Postmaster-General and Secretary, details of new ideas originated or adopted by the Post Office Engineering Department are published in this section for the information of all who may be interested.

simple, and efficiency of working is secured by the use of well-tried standard parts.

2 shows the arrangement of the various parts with the exception that two-block agglomerate cells charged with manganese chloride are the present standard practice instead of dry cells. A modification in this respect will be made when the existing stocks of battery materials have been exhausted. The hinged cover is fitted with a horizontal partition which completely separates the battery space from the upper portion containing the rest of the fittings.

Another special feature of the instrument is the provision made for dismantling the transmitter arm, writing desk, etc., thus permitting these parts to be stowed away in the portion of the instrument set apart for the battery. Risk of damage during transit is minimised in this way, and the space required for storage reduced by about one half—both important considerations.

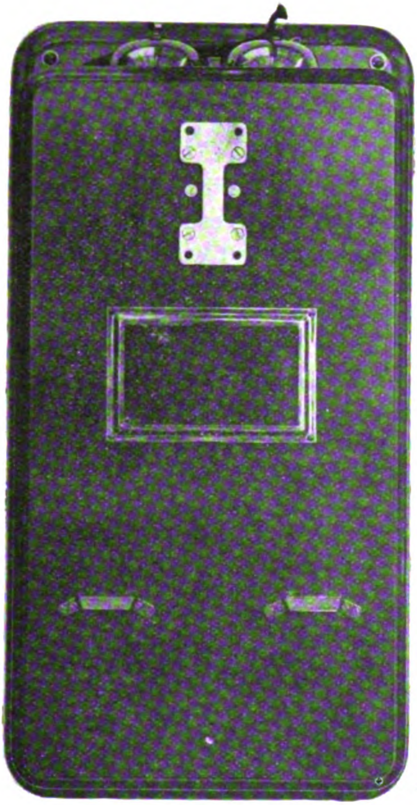


2.—New Wall Telephone open for Inspection of Internal Arrangement.

3 shows the instrument ready for packing and dispatch. All that it is necessary to do when the instrument is taken from store is to secure the two transmitter cords (No. 116) to the small screws shown, one on either side of the fixing plate, in **3**, and to fix the four base-plate fixing screws for the arm. Diagram T.L. 439B shows the connections of the instrument. In C.B.S. systems the terminal marked EB will be connected to earth or to one terminal of the extension bell where one is in use, the other terminal of the bell being connected to earth.

In the case of magneto working it will be necessary to connect the terminals EB and G by a short length of wire for normal working. Where an extension bell is required the wire should be removed and the bell connected between the terminals EB and G.

The instrument fitted with Bell Receiver and Generator No. 4 will be known as "Telephone No. 11 (Mark 238)" and where



3.—New Wall Telephone as Arranged for Transport or Storage.

the generator is omitted, as in C.B.S. working, the title will be "Telephone No. 3 (Mark 238)."

It may perhaps be convenient in this note to explain the significance of the mark numbers referred to in this and previous articles by reproducing an early headquarters' memorandum on the subject, which runs as follows:

Instruments will be recognised by descriptions consisting of the generic title and a stock-list number, *e.g.* Telephone No. 1, Generator No. 3, etc. These descriptions will be permanent so long as the instrument is not altered in such a way as to make it non-interchangeable as a whole with previous stocks. In addition to the stock-list number every variation in pattern will be denoted by a "mark" number, which will not be part of the stock description, but can be referred to, say, in requisitions for maintenance parts. The stock-list number and the "mark" number will both appear on each piece of apparatus, together with the manufacturers' code letter and the year of manufacture. The letters G.P.O. will also be added when the stamping can be done on woodwork, or other suitable surface of adequate size.

For example,

$$\text{“}\frac{\text{W. '08}}{234}\text{No. 1”}$$

on a telephone may signify that it is a Common Battery wall telephone manufactured by the Western Electric Company in 1908, that it agrees exactly in pattern with all other telephones marked 234, and that it is interchangeable in use with all other telephones marked and listed as No. 1. In the same way a telephone marked

$$\text{“}\genfrac{}{}{0pt}{}{\text{W. '08}}{236}\text{No. 1”}$$

would be recognised as differing in detail from the first mentioned, but still fully interchangeable in use. The stock-list descriptions to be quoted in requisitions and delivery notes will consist simply of the generic term and the stock-list number, *e.g.* "Telephone No. 1."

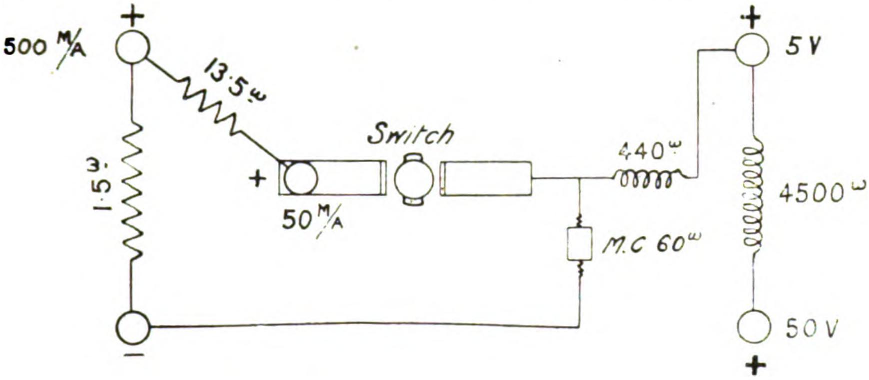
VOLTMETER AND MILLIAMPÈRE METER COMBINED.

The usefulness of the combined volt and milliampère meter described in vol. 3, Part 3, has been further increased by the provision of a fourth scale reading 0–50 milliampères, and by the conversion of the press button, used in connection with voltage tests, into a switch.

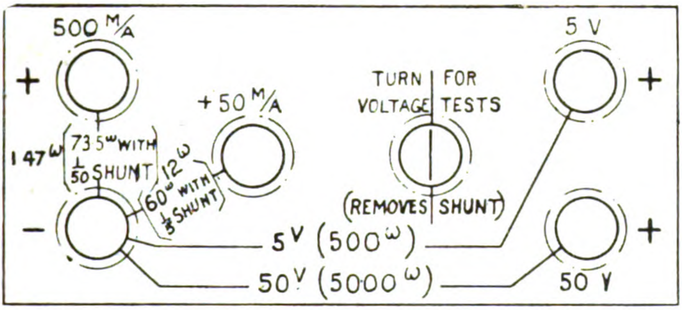
In effecting these improvements it has been necessary to add a fifth terminal and to re-arrange the shunt values on the Universal Shunt principle.

It will be seen from **1**, which gives a diagram of the connections, and **2**, which shows a plan of the top of the instrument, that the feature introduced to prevent damage to the coils in case of accidental contact with circuits carrying currents largely in excess o the normal has been retained, and that should the detector be connected up for milliampère readings, and the switch left in the voltage test position, the coil is cut out until the shunts are introduced by the operation of the switch.

The shunted position is normal, and this position is shown when the lines on the switch and the ebonite top form a continuous line.



1.—Voltmeter and Milliampère Meter Combined.



2.—Voltmeter and Milliampère Meter Combined—Plan of Terminals on Top of Instrument.

The earlier instruments will be brought up-to-date as they pass through the factory for repairs.

NOTES AND COMMENTS.

Extensions of Post Office Radio-telegraph System.

Formal approval has been given to a scheme for extending and re-arranging the service of coast stations for communication with ships at sea around the British Islands. Something approaching a complete scheme of wireless service with the object of affording to ships anywhere within 100 miles of the British coasts facilities for communicating with the shore and thence with the ordinary telegraph system of the country is involved. In formulating the details of the scheme due regard has been paid to the life-saving aspect, whereby coast-guard and life-boat stations can be immediately apprised of any ship in difficulties at sea, thus adding to the security of the seafaring community, as well as anticipating the growing demand for wireless telegraph facilities on the part of voyagers and ship owners. The scheme involves an additional station of considerable range on the west coast of Ireland for taking traffic from the large Atlantic liners away out to the westward of our shores. The provision of the station is expected to open up a further tract of ocean from, and to, which messages can be passed and so invite business, whilst also serving to relieve the wireless traffic with the existing station at Crookhaven in south-west Ireland where wireless communication is rapidly becoming congested.

At or near St. Just in Cornwall it is also intended to erect a well-equipped station capable of commanding traffic with ships entering or leaving the English Channel. This station will replace that now existing at the Lizard, and will also render the Bolt Head Station of subsidiary importance except for emergency work and wireless communication with the Channel Islands in emergencies. The new station will also serve the Irish Sea and Bristol Channel. The Niton Station is to be rebuilt and entirely remodelled, probably on a new site at St. Catherine's Point in the Isle of Wight, whilst the existing station at Rosslare on the south-east coast of Ireland will be replaced by a more powerful installation at Fishguard on the Welsh coast. The Port of Newcastle-on-Tyne is also to be catered for by the Post Office, and the existing station at Malin Head on the North Coast of Ireland is to be replaced by a more modern and powerful station in the neighbourhood, but situated in a position of greater accessibility and provided with accommodation more suitable for the operating staff. In regard to the north coast of Scotland, the amount of shipping traffic of a calibre to carry wireless telegraph apparatus is not at present considered sufficient to justify the provision of any coast station in that neighbourhood.

SECRETARY TO THE POST OFFICE.

Early in August it was announced that Sir Matthew Nathan, G.C.M.G., before completing twenty months as Secretary to the Post Office, had been appointed by the King to be Chairman of the Board of Inland Revenue in succession to Sir Robert Chambers, K.C.B., who had been appointed Permanent Secretary of his Majesty's Treasury.

This is an unusually short tenure of office for the ruler of our great organisation, and we may contrast it with the periods of five of his predecessors.

Sir H. Babington Smith, K.C.B., C.S.I., reigned for six years.

He succeeded Sir G. H. Murray, K.C.B., who had reigned for four and a half years.

He succeeded Sir Spencer Walpole, K.C.B., who had reigned for five and a half years.

He succeeded Sir S. A. Blackwood, K.C.B., who had reigned for thirteen years.

He succeeded Sir John Tilley, K.C.B., who had reigned for sixteen years.

Sir Matthew's five predecessors thus cover a period of forty-five years, and reach back to the time of Sir Rowland Hill.

During the same period there were nineteen Postmasters-General.

As successor to Sir Matthew Nathan we have Sir A. F. King, K.C.B. Sir Alec's connection with the Post Office dates from 1873, and he has been Second Secretary from June, 1905, previous to which he was for two years one of the assistant secretaries. The selection of an officer from within the Post Office for the premier position has given universal satisfaction. Mr. Edward Crabb, C.B., becomes Second Secretary, and in view of the approaching transfer of the National Telephone Company's business to the Post Office, and in order to secure a proper co-ordination of the work of the Telegraph and Telephone Departments, the Postmaster-General has established a post of Third Secretary, with supervision over these departments. Mr. A. M. Ogilvie, hitherto Assistant Secretary in Charge of the Telephone Department, has been appointed Third Secretary. Mr. A. B. Walkley and Mr. L. T. Horne have been promoted from principal clerks to be Assistant Secretaries to the Post Office.

ARBITRATION.

Those engaged in the legal fight between the Post Office and the National Telephone Company who had not succumbed during May or June to the combined effects of the torrid weather, the close atmosphere of the Law Courts, and the interminable examinations and cross-examinations in order to make crooked that which is straight, or it may be *vice versâ*, returned on July 3rd to the court of the Railway and Canal Commission.

Sir Alfred Cripps, resuming for the Company, called Mr. Frank Gill, and proceeded in the endeavour to demonstrate that the condemned plant was suitable, and that the Post Office plans would cause great public inconvenience owing to the difficulty of transferring subscribers from one exchange to another. Mr. Gill was in the witness-box for three days, and undoubtedly proved a good witness, making the most of the Company's case.

On the subject of "Magneto" *versus* "Common Battery" he reported such excellent results from Magneto exchanges that experts felt that the fate of the C.B. system hung in the balance. He was followed by Mr. W. W. Cook, Assistant Engineer-in-Chief to the Company, who dealt principally with plant on railways and with transfer difficulties.

Following these two expert telephone engineers, whose evidence was heard by those in court with keen interest, there came a weary succession of *expert witnesses* and interest flagged.

Mr. H. F. Parshall, Chairman of the Central London Railway, described his sixty-point telephone system on the "Twopenny Tube," and with regard to the Avenue Exchange, stated that it was "working as well as telephonic work anywhere in the world." He had been to Avenue, and had seen no signs of preparations for the transfer which, he said, one would expect to see there, if the system of connections was to be taken over in six months. Mr. S. Z. de Ferranti, President of the Institution of Electrical Engineers, and Sir Alexander Kennedy followed. Next came Mr. Hammond V. Hayes, who had had charge of the experimental work of the American Telephone and Telegraph Company from 1885 to 1907, and claimed to have originated the solid back transmitter and the common battery system. From him Counsel inquired "and *all the devices for protecting telephone wires* from affection by high-powered cables were also experimented with and introduced by you?" Witness replied airily, "Similarly developed in my laboratory."

Counsel: "It is not merely the high voltage but all foreign bodies?"

Witness: "A general protective system of telephone exchanges and apparatus." This witness expressed his approval of the combination of underground and aërial wires and of aërial cables, and stated that it was the method approved in the United States, and was "in a great measure very similar to the construction here." In cross-examination, however, Sir Rufus Isaacs elicited that the witness had seen the cables on the roofs at Avenue, that "they had nothing like that now," but that similar conditions had prevailed in the States when the witness began business *twenty-two years ago.* Now, all cable is carried on the sides of the houses and not on the house-tops. Some amusement was produced by the Attorney-General exhibiting a copy of the American "Electrical Review" containing two pictures contrasting the aërial cables of 1890 with the underground ducts of 1909 in Broadway, New York.

Mr. James Swinburne, F.R.S., and Past President of the Institution of Electrical Engineers, another well-known expert witness, followed Mr. Hayes, and proved to be the last witness heard in the case.

On July 11th the Commissioners did not come into Court, and a period of waiting almost equal in weariness to that of some of the preceding days ensued while negotiations between the principals on each side took place. Finally at 1.30 the court assembled and the Attorney-General announced that a form of declaration had been agreed upon. The Commissioners looked much relieved and Mr. Justice A. T. Lawrence said they were extremely pleased. The case for the Post Office was therefore not presented, and those who had prepared themselves for the trying ordeal of the witness-box relaxed themselves in various ways according to temperament. No doubt much of the ammunition which had been prepared will be available for the final engagement. It was subsequently announced that it had been agreed that the whole of the Post Office notices of objection relating to character, etc., would stand, subject to certain modifications. The notices referring to the competitive areas would be withdrawn, except in the case of Abergavenny. In these competitive areas the Post Office will buy all the plant subject to the two following conditions:

(1) A separate total to be ascertained for all plant (other than instruments hereafter mentioned), land, and buildings, which lie within a radius of 150 yards of any exchanges objected to, including the exchanges and their equipments, and the Postmaster-General shall pay only 50 per cent. of such total.

(2) A separate total to be ascertained by such valuation for all instruments to be purchased of the local battery type connected with objected-to exchanges, and the Postmaster-General shall pay only 62½ per cent. of such total.

Any difference is to be decided by the Attorney-General and Sir Alfred Cripps, or if they fail to agree, then by the Railway Commissioners.

So far as the Company is concerned it is gathered from the proceedings at the Forty-eighth Ordinary General Meeting that the settlement was one which the directors cordially approved. We take the following paragraph from Mr. Franklin's speech as given in the September issue of the Company's Journal:

"He could not pass from that bare recital of what had been happening with regard to that recent litigation without expressing the deepest obligations of the Company to its counsel, its solicitors, its engineers, and the whole of its staff, from, he was going to say, top to bottom, who had thrown themselves into the case with a zeal and energy which he thought was beyond praise; and it had in fact been a position of enormous difficulty owing to the technicalities which had to be overcome, and these recent actions really constituted a very heavy task upon the Company's officers. That work was done at a time when a large portion of the staff of the Company was engaged upon the inventory, which had not been delayed for a moment by reason of these proceedings, and therefore the burden upon the officers of the Company had been all the greater. He was sure they (the shareholders) would wish him to express to the officers—as he should like to do also on behalf of the Board—their warm appreciation."

We think this is a very handsome tribute which our future colleagues have well earned. Unfortunately the Post Office has no half-yearly meetings, and so we have no parallel paragraph in our JOURNAL for the Post Office Solicitor, engineers, and staff, who worked with equal zeal and energy. On the other hand, we have to deplore the fact that the heavy strain of the case resulted in serious illness to Sir John Gavey—whose absence at a critical juncture was little short of a calamity—and in a serious nervous breakdown to Mr. William Brown, whose long connection with Post Office telephones has made him one of the best known and highly appreciated telephone men in the country. Just as we go to press it is announced that he will not be able to resume his duties. "The case" has therefore terminated his official career.

LOCAL CENTRE NOTES.

SOUTH WALES CENTRE.

THE Local Committee has made arrangements for the meetings to be held in the Library of the South Wales Institute of Engineers at Cardiff during the forthcoming session.

The programme includes the undermentioned papers, and the dates upon which they will be read will be published shortly: "Departmental Contracts," W. S. Mountain; "Maintenance and Faults," J. W. Martin; "Wayleaves," E. D. Careless; "Main Underground Work," A. W. Sirett; "Wireless Telegraphy," W. Pennington; "Office Organisation and Equipment," P. E. Milford.

LIBRARY NOTES.

The following books have been added to the Library and are available for the use of members :

No.
35. ‘Guide to Commercial Finance.’ A. J. Deacon & Co.
36. ‘Solenoids, Electro-Magnets, and Electro-Magnet Windings.’ C. R. Underhill.
37. ‘Transmission Calculations.’ L. W. Rosenthal.
38. ‘Three-Phase Transmission.’ W. Brew.
39. ‘Engineering Mathematics.’ C. P. Steinmetz.
40. ‘Practical Mathematics and Geometry.’ E. L. Bates and F. Charlesworth.
41. ‘Manual of Wireless Telegraphy.’ Lt.-Commdr. Robison.
42. ‘The Bell Telephone.’ American Bell Telephone Co.
91. ‘Tutorial Trigonometry.’ W. Briggs and G. H. Bryan.
92. ‘Synopsis of Trigonometry.’ W. Briggs.
93. ‘Applied Mechanics for Beginners.’ J. Duncan.
183. ‘Modern Arithmetic.’ H. S. Jones.

NEW EDITIONS.

284. ‘Electric Wiring.’ W. P. Maycock.
101. ‘Practical Electricity.’ W. E. Ayrton and T. Mather.
316. ‘Applied Mechanics,’ vol. i. A. Jamieson.

NEW BOOKS.

‘Practical Dynamo and Motor Management.’ (S. Rentell & Co., Ltd., 36, Maiden Lane, W.C. Price 6*d.* net.)

This is a handy little booklet of 48 pages, well printed and illustrated, giving clear instructions to machine attendants for dealing with the various troubles of D.C. and A.C. machines.

‘Whittaker's Arithmetic of Electrical Engineering.’ (Whittaker & Co., 2, White Hart St., Paternoster Square, E.C. Price 1*s.* net.)

We can recommend this book to those students of electrical engineering who are in earnest and desire to do thoroughly good work. Such work always involves a very thorough drilling in arithmetic, and it is a great assistance to have it mapped out for one on a systematic plan. The book contains 72 worked examples, and 300 exercises, including most of the numerical questions set at the City and Guilds examinations in lighting and power transmission and telegraphy and telephony.

'The Post Office: An Historical Summary.' Published by order of the Postmaster-General. (Published by H.M. Stationery Office, and to be purchased at any head or branch P.O. or from Wyman & Sons, Fetter Lane, E.C.; Oliver and Boyd, Tweeddale Court, Edinburgh, and E. Ponsonby, Ltd., 116, Grafton St., Dublin. June 1911. Price 9*d.*, or ¼ bound, 1*s.*)

The first issue of this official history apparently consists of 2000 copies, and if they are not already bought up we think our readers—or at any rate those of them who regard the Post Office as *alma mater*—would do well to order copies at once. In a volume, similar in size to our JOURNAL and with 140 pages, and six very good half-tone illustrations on art paper, we have a concise history of the Post Office from the days of the King's despatch relays in 1482 to the Telephones and Wireless Telegraphy of the present day. One cannot avoid noting here that the aërial post came just too late to obtain inclusion, but a perusal of the contents list suggests that this is the only service which has not been included. We regret that we have not space available for any quotations. Work of this kind too frequently passes with but small recognition, and we therefore take this opportunity to tender to those responsible for the initiation and execution of this work our grateful acknowledgment of a good work well done.

NEW BOOKS IN OUR LIBRARY.

On another page will be found a list of books recently added to our Library and now available for issue.

It should be made known to members of the Institution that these books are selected from large numbers sent in by publishers after they have been carefully examined by members of the Library Committee, so that their appearance in this list implies an endorsement of their character and suitability. C. P. Steinmetz, 'Engineering Mathematics,' which we referred to in our last issue, is included in this list.

Another work included which is worthy of special reference is Commander Robison's 'Manual of Wireless Telegraphy.' This book has been prepared for the Naval Electricians of the United States, and is a model of clarity and succinctness, and to the *practical* wireless telegraphist it should have a high value. The book has been published by the United States Naval Institute; printing, diagrams and illustrations are all of the best class. Copies may be had in this country from S. Rentell & Co., Ltd., 36, Maiden Lane, Covent Garden, E.C., at 7*s.* 6*d.* net

WIRE TABLES.—The London Electric Wire Company and Smiths, Ltd., have just issued in pocket style a set of wire tables, giving diameters, areas, weights, resistances and currents for all S.W.G. sizes of copper conductors, fuse tables, comparisons of gauges and other useful data.

They ask us to state that they will be pleased to send copies to any of our readers on application.

TRADE LISTS.—Messrs. The India Rubber, Gutta-Percha and Telegraph Works Company, Ltd., have just published a new set of lists of their manufactures, and desire us to intimate to our readers that they will be pleased to forward sets to *bonâ fide* applicants.

STATION LIST SUPPLEMENT.

THE Board of Editors are pleased to be able, by the kind courtesy of the Engineer-in-Chief, Major O'Meara, to issue with this number a new edition of the Station List. It includes the Headquarters Engineers and the District Engineers to the end of the second class. The remainder of the engineer officers and the whole of the clerical staff will be given in a supplement to be issued in January. In order to facilitate the making of corrections, which are notified in our quarterly lists of Promotions and Transfers, the Station List is printed on one side of the paper only. A good way to preserve them is to paste them on thin cardboard.

NOTES FROM AMERICA.

WE stated in our last issue that Messrs. Martin and Jones would contribute to this issue articles dealing with their American visit. Unfortunately for us, and for our readers, in the interval another International investigation has claimed the services of both these gentlemen, and it has not yet been possible for them to carry out their kind intentions.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT (LONDON).

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
E. in C.O.	Thorne, A. E.	Clk., 2nd Class	2nd Cl. Exr., Tel. Stores Dept., '99; 3rd Cl. Clk., E.-in-C.O., '03.
„	Roberts, E. S.	„	S.C.&T. Bristol, '00; 3rd Cl. Clk., E.-in-C.O., '05.

RETIREMENTS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Cowans, J.	Engr., 2nd Cl.	1870; Insp., '78; Engr., 1st Cl., '93.
„	Moody, H. C.	Clk., 3rd Cl. (Provs.)	C.C.&T., L.P.S., '92; Jr. Clk., Eng'g. Dept. '03.

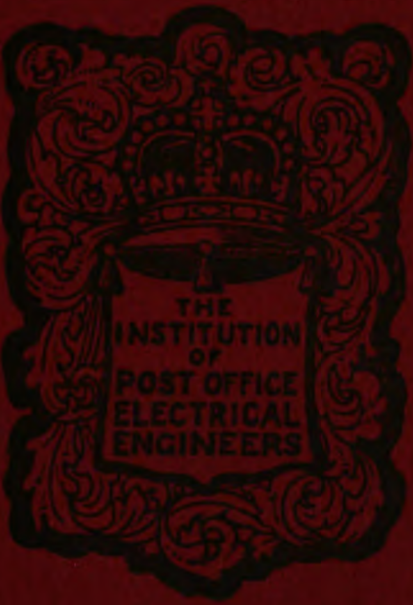
TRANSFERS.

Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Beeton, H. G.	2nd Cl. Engr.	E. in C.O.		Sc.W.	1 : 6 : 11
Cresswell, H. G. B.	Ditto	„		Sc.E.	9 : 6 : 11
James, W.	3rd Cl. Clk.	Sc.W.		S.E.	11 : 6 : 11
Parish, G. J.	2nd Cl. Clk.	Met. S.		E.L.	9 : 6 : 11
Timson, J. R.	„	E.L.		Met. S.	9 : 6 : 11
Lyle, R.	3rd Cl. Clk.	N. Wa.		S.E.	18 : 6 : 11
Bewley, H. L.	„	N.W.		N.Wa.	18 : 6 : 11
Nevill, A. J.	„	S.E.		Met. C.	14 : 8 : 11
Martin, H. E.	„	Met. C.		S.E.	14 : 8 : 11
Dunn, F. G.	„	S.E.		Met. C.	21 : 8 : 11
Evans, T.	2nd Cl. Engr.	N.E.		Sc.W.	27 : 8 : 11

COMMUNICATIONS.

All Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOL. 4
PART 4

JAN:
1912

ADVERTISEMENT INDEX SEE PAGE

ESTABLISHED 1879.

THE

LONDON ELECTRIC WIRE COMPANY
AND SMITHS, LTD.

Telegrams: "Electric, London." Telephone: No. 3109 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

Every Description of Cables &
Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.
Silk-Covered Wires for Electrical Instruments.
Enamel Insulated Wires.
Multiple Cables for Telephones, &c.
Flexible Cords of all descriptions for Incandescent Lamps, &c.
Dynamo Brushes.
"Platinoid," "Eureka," AND OTHER **High Resistance Wires.**

Antwerp Telephone & Electrical Works,
ANTWERP.

Manufacturers of

TELEPHONIC APPARATUS
OF EVERY DESCRIPTION.

Wall Sets
Table Sets
Switchboards
Standard and Multiple
Domestic Sets

Bells
Receivers
Transmitters
All Accessories

Sole Agents for the United Kingdom—

W. F. DENNIS & CO.,
49, QUEEN VICTORIA STREET,
LONDON.

Stores: MILLWALL DOCKS, E.

Telegrams: "FREDENNIS, LONDON." Telephone: BANK 343.

We have made great advances in the design and manufacture

OF

Continuously

Loaded

Paper Insulated

TELEPHONE

CABLES.

IF YOU ARE INTERESTED
PLEASE
COMMUNICATE WITH US.

British Insulated & Helsby Cables,
LTD.
Electrical Cable Makers & Engineers.
Head Office: PRESCOT, Lancashire.
Works: Prescot, Helsby and Liverpool.

The Post Office Electrical Engineers' Journal.

A QUARTERLY JOURNAL.

CONTENTS FOR JANUARY, 1912.

COPYRIGHT.—The entire contents of this Journal are covered by general copyright, and special permission is necessary for reprinting long extracts, but Editors are welcome to use not more than one third of any article provided credit is given at the beginning or end thus: "From the 'Post Office Electrical Engineers' Journal.'"

FRONTISPIECE— PAGE

Illustrating Mr. J. E. Gibbons's Article, "The Diversion of Underground Plant."

CONSTRUCTION—

The Diversion of Underground Plant—J. E. Gibbons 289

TIMBER—

The Decay and Preservation of Timber—W. H. Matthews, B.Sc. (*continued from page* 251) 300

INDUCTANCE—

Inductance of Telegraph Apparatus 309

TELEGRAPHS—

Fast-speed Wheatstone Working on Underground Cable Circuits—A. Fraser 321

TELEPHONES—

Putney Telephone Exchange Transfer to New Premises—J. L. Taylor 326
An Automatic Counter for Subscribers' Effective Calls—P. V. Christensen 338
NEW IDEAS 341
CABLE FAULTS AND THEIR REMOVAL: AN EXPERIMENT ... 345

NOTES AND COMMENTS—

Anglo-Belgian Telegraph Commission, 1911 347
The "Automatic" Situation 349
The Revision 354
The Transfer 355
LOCAL CENTRE NOTES 355
ENGINEERING DEPARTMENT CHESS CLUB 366
CORRESPONDENCE 367
ELECTRICAL ENGINEERS AND THE PUBLIC 368
IN INDIA 370
THE MARCONIGRAPH 370
LIBRARY NOTES 371
NEW BOOKS 371
NEW LISTS 372
RETIREMENT OF MR. W. BROWN 372
STAFF CHANGES 375

PUBLISHERS:
H. ALABASTER, GATEHOUSE & Co., 4, LUDGATE HILL, E.C.

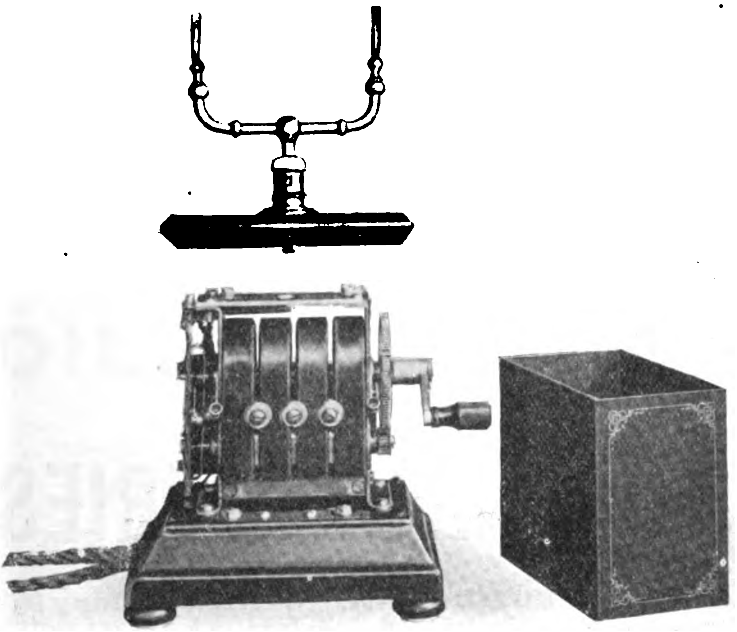
Price 1/- nett.
Single Copies, post free, 1/3.

Annual Subscription,
4/-, paid in advance.

ERICSSON

Table Instrument

(Pattern 1907—All Steel).



Advantages over other Makes.

The whole of the working parts are mounted on the base. The top and cover are removable; no loose cabling attached to cradle. All parts easily accessible for examination.

PRICES ON APPLICATION.

MAKERS:

British L.M. Ericsson Manufacturing Co., Ltd.,
BYRON HOUSE, FLEET STREET, E.C.

WORKS:
BEESTON, NOTTS.
Also at
Stockholm, Sweden,
And
St. Petersburg, Russia;
Buffalo, N.Y., U.S.A.

TELEPHONE:
5340 HOLBORN.

TELEGRAPHIC ADDRESS:
"ERICSSON, LONDON."

HART

ACCUMULATOR CO.,
LTD.

OUR . . . .

1912 Illustrated Catalogue

— OF —

"HART"

STORAGE BATTERIES

IS NOW ISSUED. Have you had a Copy?

Special Cells for Telegraph,
Telephone, Testing
and Laboratory Work.

ESTIMATES ON APPLICATION.

Head Office and Works: STRATFORD, LONDON.

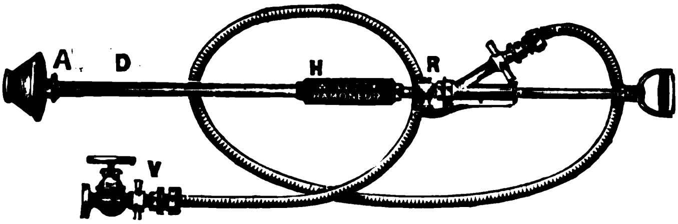
Telephones: 1306 / 1307 EAST.

Telegrams:
"HARTMOSSEL, LONDON."

THE . . .

"WILLCOX-RAMONEUR"

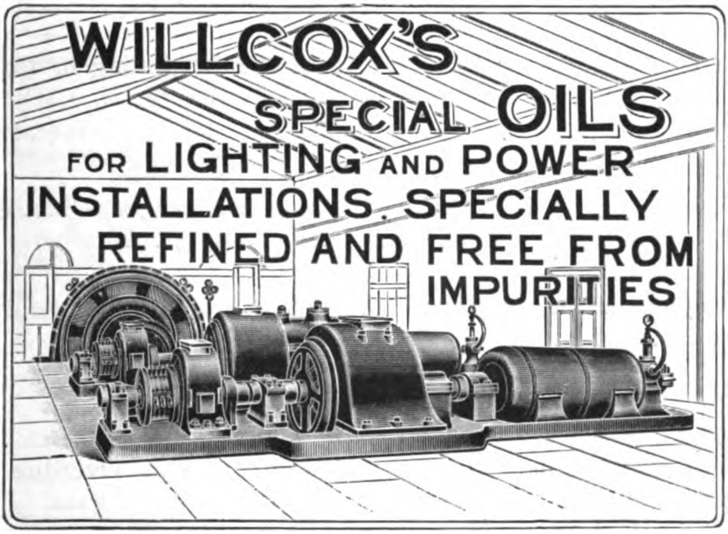
—.SHOULD BE IN EVERY BOILER HOUSE—
WHERE TUBULAR BOILERS ARE INSTALLED.



SOOT or ASHES are removed quickly, thoroughly, harmlessly, by perfectly **DRY PROCESS.**

FULLEST INFORMATION ON APPLICATION.

OILS **for LUBRICATING ENGINES and PLANT in ELECTRIC LIGHT WORKS.**



Our **Turbine, Cylinder, Crank Chamber,** or **Dynamo, Engine,** and **General Lubricating Oils** are in use in most of the principal Lighting and Power Installations throughout the country.

Our New Booklet

describes our different qualities for each requirement, and we shall be pleased to forward copy to engineers.

W. H. WILLCOX & Co., Ltd.,
23, 32, 34, 36 & 38, Southwark St., London.

The National ◆ ◆ ◆

Telephone Journal

A Journal devoted to Telephony.

PRINCIPAL CONTENTS OF NOVEMBER, DECEMBER, AND FINAL ISSUES (the latter to be published in the middle of January, 1912):

Portraits and Biographies of Messrs. E. E. Stockens, G. F. Greenham, and W. E. Hart.

The History of the National Telephone Company: The Trials, Tribulations, and Triumphs of Thirty-three Years. BY ALBERT ANNS. (*Fully Illustrated.*)

The Education and Training of the Telephone Engineer. BY G. F. GREENHAM.

The Telephones of the World at the Beginning of 1911. BY W. H. GUNSTON.

The Bartholomew House Exchange. BY P. J. MANTLE.

The Commercial Mind. BY EUSTACE HARE.

Daily Originating Traffic, Bristol Exchanges: Its Value, Operating Duties and their Management. BY A. E. COOMBES.

Copper Wire: A Brief Account of its Development and Manufacture. BY F. D. LATIMER.

EDITORIALS.

The Coming Transfer.—Taking Time by the Forelock. — Presentations. — Coming Changes. — The Overdue Classification Scheme. — The Automatic Again. — A Farewell—1911.

Annual Subscription 4/-, post free.
Price 3d. monthly, or 4½d. post free.

TELEPHONE HOUSE,
VICTORIA EMBANKMENT,
LONDON, E.C.

SILK AND COTTON
COVERED
COPPER AND HIGH RESISTANCE WIRES
·001″ and thicker.

BELL WIRES & CORDS, INSULATING TAPES,
Isolacquered SILK, LINEN & PAPER.
SILK & COTTON TAPES & SLEEVING, GLASS BEADS, &c., &c.

HIGH RESISTANCE WIRES
Stocked in all sizes.
CONCORDIN,
VESTALIN,
CONSTANTAN,
RESISTIN,
MANGANIN,
NICKELIN,
GERMAN SILVER (All Grades),
OHMAN,
FRANKLIN
and others.

All Constructions of
FLEXIBLE CORDS and CABLES.

THE
CONCORDIA Electric Wire Co., Ltd.

WORKS (and Offices):
"THE WIRE WORKS,"
Crown Parade,
Cricklewood Lane,
London, N.W.
Telegrams: "POLIANITE, LONDON."
Telephone: P.O. HAMPSTEAD 5360.

JAPANNED MAGNET WIRES

TELEPHONE CORDS.

Write for Section 102 of our Catalogue, which will give full details of our
ASBESTIN COVERED WIRES
for all classes of Apparatus liable to overcharge of currents.

READY WOUND COILS
to any Specification a Speciality.

ARC LAMP AND CARBON BRUSH FLEXIBLES.
AUTOMOBILE CABLES
For HIGH or LOW Tension.

BRITANNIA

Telegrams:
"Britannia, London."

Telephone:
12028 Central.

RUBBER & KAMPTULICON CO., LTD.

BRITANNIA RUBBER & KAMPTULICON COMPY

7, NEWGATE STREET,
LONDON, E.C.

STEAM WORKS,
BOW COMMON.

Ebonite & Vulcanite
FOR ELECTRICAL INSULATION, ETC.

PURE PARA STRIP & RUBBER COMPOUNDS.

GALALITH—Sheets & Rods All Colours—Red, White, Blue, Green, Yellow, Black, etc.

I.R. Sheet, Tubes and Moulded Articles for Mechanical, Chemical, and Electrical Purposes.

WATERPROOF & RAINPROOF COATS in great variety.

If you wish to be kept well informed
▪ ▪ on the latest developments of ▪ ▪
WIRELESS TELEGRAPHY

READ THE

MARCONIGRAPH

AN ILLUSTRATED MAGAZINE WITH NEWS DERIVED FROM ALL PARTS OF THE WORLD.

PUBLISHED ON THE FIRST OF THE MONTH

Yearly Subscription, Post Free, THREE SHILLINGS.	PRICE 2D.	Single Copies, by Post, THREEPENCE.

PUBLISHED BY

Marconi's Wireless Telegraph Co., Ltd.,
Watergate House, York Bldgs., Adelphi, London, W.C.

On sale at all Railway Bookstalls and can be obtained through any Newsagent.

"The Zodiac,"

The Cableman's Paper.

A Monthly Magazine representing the Social Life of the World of Cablemen in the Home Countries and Overseas: their Sport, Art, Literature, and the Gossip of the Ships and Stations.

Illustrated with beautifully reproduced Photographs and many charming Drawings.

SIXPENCE MONTHLY.

YEARLY SUBSCRIPTION, Post Free, to any part of the World, **6s.**

Published by THE ZODIAC PUBLISHING CO., Ltd.,
Electra House, Finsbury Pavement,
LONDON, E.C.

THE
CRYSTALATE MFG. Co., Ltd.
TONBRIDGE, KENT,
ENGLAND.

Telegrams:
"Crystalate, Hadlow."

Telephone:
No. 33 Hadlow.

Telephone
Fittings.

SPECIAL ATTENTION IS CALLED TO THIS

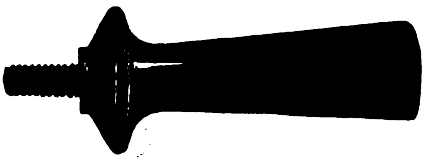
Crystalate Mouthpiece

which has
moulded in,
increasing
and

brass screw
infinitely
strength
lasting power.

Ear and Mouthpieces
. . of every description. . .

Insulators, Bushing Pieces, Washers & Handles, &c.



LIST OF PROFESSIONAL PAPERS

PUBLISHED BY

THE COUNCIL OF THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

	Price.	Post free.
"The Telegraph Acts."—Mr. R. McIlroy	9d.	10d.
"Telephone Transmission" (with diagrams).—Mr. J. G. Hill	9d.	10d.
"Electric Wave Propagation" (with diagrams).—Mr. J. E. Taylor	9d.	10d.
"The Construction of Telephone Lines" (with diagrams).—Mr. A. Moir	9d.	10d.
"The Baudot Printing Telegraph System" (with diagrams).—Mr. A. C. Booth	1s.	1s. 3d.
"Quadruplex Repeaters" (with diagrams).—Mr. J. N. McCurdy	6d.	7d.
"Improvements in Telephonic Transmission over Underground Circuits by the Insertion of Inductance Coils" (with diagrams).—Mr. T. Plummer	1s.	1s. 2d.
"Underground Construction (Provinces)" (with diagrams).—Mr. A. O. Gibbon	9d.	10d.
"The Construction of Aërial Lines" (illustrated).—Mr. J. H. M. Wakefield	1s.	1s. 2d.
"The Education and Training of an Engineer."—Sir John Gavey, C.B.	6d.	7d.
"A Description of Some Typical Processes in the Manufacture of Dry Core Cable."—Mr. R. W. Callender	9d.	10d.
"A Reply to Criticism of Murray Automatic Printing Telegraph System."—Donald Murray, M.A.	6d.	7d.
"Inspection of Wrought Timber."—Mr. F. L. Henley	9d.	10d.
"The Calculation of Current Values in Networks."—Mr. J. Lockhart	9d.	10d.
"Protection from Power Circuits."—Mr. S. C. Bartholomew	1s.	1s. 2d.
"Wireless Telephony."—Mr. R. Lawson	9d.	11d.
"Underground Telegraphs."—Mr. G. H. Comport	6d.	7d.
"The Education of the Post Office Electrical Engineer."—Mr. A. W. Heaviside, I.S.O.	6d.	7d.
"The Theory and Development of Central Battery Telegraph Systems."—Mr. J. Fraser	9d.	10d.
"Aërial Wire Construction, with Special Reference to the Elastic Properties of Copper Wire."—Mr. G. M. Carr	6d.	7d.
"Depreciation."—Major W. A. J. O'Meara	1s.	1s. 1d.
"Alternating Current Measurements."—Mr. A. G. Lee, B.Sc., A.M.I.E.E.	9d.	10d.
"The Loading of Telephone Cable Circuits."—Mr. A. W. Martin	1s.	1s. 2d.
"The Erection and Maintenance of Post Office Secondary Cells."—Mr. W. J. Medlyn	6d.	7d.
"The Law of Contracts."—Mr. D. Aikenhead Stroud, LL.B.	6d.	7d.
"Pneumatic Despatch."—Mr. H. R. Kempe, M.Inst.C.E., M.Inst.E.E., M.R.I.	6d.	7d.

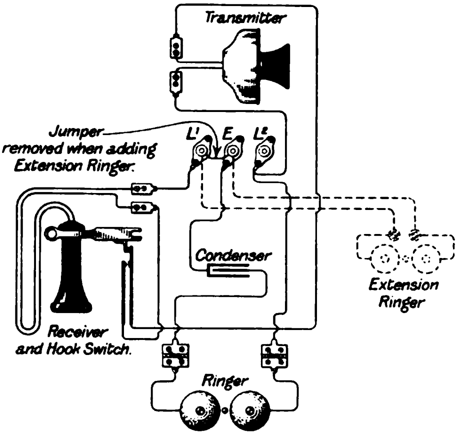
H. ALABASTER, GATEHOUSE & CO.,

4, LUDGATE HILL, LONDON, E.C.

PEEL-CONNER
TELEPHONE WORKS, L^TD.

MANUFACTURERS and INSTALLERS of all sizes and types of SWITCHBOARDS and SUBSCRIBERS' INSTRUMENTS.

SPECIALISTS in LARGE MULTIPLE CENTRAL BATTERY & GENERATOR CALL EXCHANGE EQUIPMENTS.


Transmitter
Jumper removed when adding Extension Ringer.
L1
E
L2
Condenser
Extension Ringer
Receiver and Hook Switch.
Ringer

CENTRAL BATTERY TELEPHONE CIRCUIT.
Peel-Conner Telephone Works Ltd.

EQUALLY EFFICIENT for long distance or local service.

NO induction coil necessary.

TRANSMISSION unequalled.

TABLE SETS require TWO conductor cord only.

RECEIVING greatly improved by use of specially designed ELECTRO-MAGNETIC RECEIVER containing NO PERMANENT MAGNET rendering deterioration or loss of permanent adjustment impossible.

Head Office:

PEEL WORKS,
SALFORD, LANCS.
Telephones: 2183 & 2186 CENTRAL.
Telegrams:
SPRINGJACK MANCHESTER.

London Office:

MIDLAND BANK CHAMBERS,
QUEEN VICTORIA ST., E.C.
Telephone: 673 LONDON WALL.
Telegrams:
PEELCONTEL LONDON.

The "Electrical Review."

Established
—1872—

THE OLDEST AND YET MOST UP-TO-DATE
ELECTRICAL NEWSPAPER IN THE WORLD.

Electric Traction - -
Power, Lighting, &c.

Reliable, Unbiassed,
Original, Invaluable.

HAS BY FAR THE LARGEST CIRCULATION OF ANY
ELECTRICAL INDUSTRIAL PAPER IN GREAT BRITAIN.

UNRIVALLED AS AN ADVERTISING MEDIUM.

Scale of Charges for Trade Advertisements on application.
Special Prepaid Rate of Advertisements of Situations Vacant or Wanted.

Published Friday 9 a.m.,
$4\frac{1}{2}$d. Post Free.

Advertisements received up to 9.30 a.m. on Thursday.

LONDON:
H. ALABASTER, GATEHOUSE & CO.,
4, Ludgate Hill, E.C.

LAMSON PNEUMATIC TUBE CO. L$^{D.}$
LAMSON STORE SERVICE CO. L$^{D.}$

Constructors of Pneumatic and Automatic Systems for Conveying Letters, Telegrams, Orders, Documents, etc.

Lamson **Wire** Carriers and Small Lifts, especially adapted for Offices and Government Departments.

Lamson **Tubes** have many patented features, notably for saving power, reducing cost of installation and greatly increasing efficiency.

World-wide Organisation—many important Government Contracts carried out for Colonial and Foreign Post Offices and Public Works Departments.

Fullest information, plans and estimates free on application to

Head Offices: 20, Cheapside, London.

PARIS. BERLIN. SYDNEY. WELLINGTON. CAPETOWN.

Telegrams:
"INSTANTLY, LONDON."

Ebonite.

Telephone:
3186 CENTRAL.

DR. HEINR. TRAUN & SONS.

Works: HAMBURG, HARBURG & NEW YORK.

LONDON AGENCY: 25, GOSWELL RD., E.C.

F. WINTER, Manager. **G. ALMENRÄDER, Assist. Manager.**

Contractors to the Post Office

And many other Government Departments.

MANUFACTURERS OF EBONITE AS A SPECIALITY,

With an unrivalled experience of over **50 years,** which we are always willing to place at the disposal of our customers.

About 2000 hands are constantly employed at our works turning out **EBONITE** in any form or shape.

Vulcanite.

“St. Martin’s-le-Grand”

THE

POST OFFICE MAGAZINE.

21st Year of Publication. ✽ **PUBLISHED QUARTERLY.**

Devoted to

POST OFFICE, LITERARY, SCIENTIFIC AND ARTISTIC SUBJECTS.

Always Well Illustrated.

A List of the recent Promotions, Retirements, and Deaths in the Postal Service of the United Kingdom appears every quarter.

Circulates throughout the Post Offices of the United Kingdom, the British Colonies, and Foreign Countries.

3/- PER ANNUM. SINGLE COPIES **9d.**

Post Free.

N.B.—Any profit resulting after due provision has been made by the Management for an adequate reserve is applied to the assistance of Literary, Artistic or Benevolent enterprises within the Post Office. An Annual Balance Sheet is published in the Magazine.

Hon. Treasurer: ARTHUR G. FERARD.
Hon. Editor: EDWARD BENNETT.
Assistant Editor: R. W. HATSWELL.

All Communications to be addressed—
c/o Messrs. W. P. GRIFFITH & SONS, Ltd.,
Old Bailey, London, E.C.

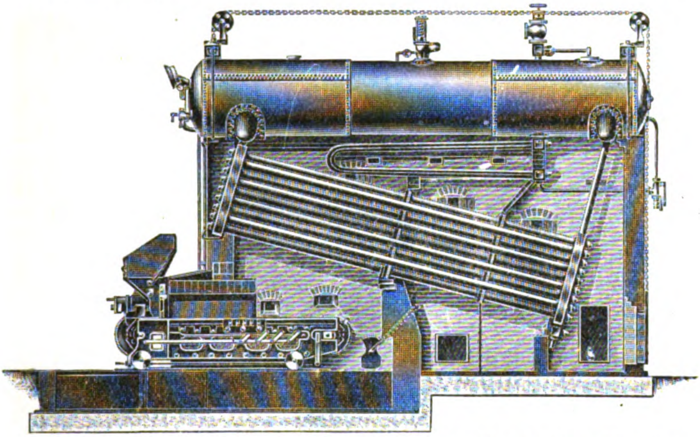
ADVERTISEMENTS—For Terms apply to Messrs. Griffith & Sons.

BABCOCK & WILCOX

PATENT **LTD.**

WATER-TUBE STEAM BOILERS.

OVER { **8,600,000 H.P. Land Type** } **Installed**
{ **2,200,000 H.P. Marine Type** } **or on Order.**



BABCOCK & WILCOX Boiler, fitted with Patent Superheater and Chain Grate Stoker.

OVER

2,600,000 H.P. in Electric Light, Power & Traction Stations.

Babcock & Wilcox also manufacture

WHITE-FORSTER WATER-TUBE MARINE STEAM BOILERS.

STEAM SUPERHEATERS.
MECHANICAL STOKERS.
ECONOMISERS.
FEED-WATER HEATERS.
WATER SOFTENERS AND PURIFIERS.
STEAM PIPING PLANTS.
STRUCTURAL STEEL WORK.
STEEL CHIMNEYS.
COAL-CONVEYING MACHINERY.
ELECTRIC CRANES.

And all Boiler House Accessories.

Telegrams:
"Babcock, London."

HEAD OFFICES:

Telephone:
No. 5540 Holborn (8 lines).

Oriel House, Farringdon St., London, E.C.

Works: RENFREW, SCOTLAND.

"Reduce your Battery Expense."

WESTERN ELECTRIC COMPANY LIMITED LONDON
CABLES TELEPHONE APPARATUS
TRADE MARK

On the Basis of Actual Work Done for Money Expended the Blue Bell Dry Cell is the Cheapest Marketed.

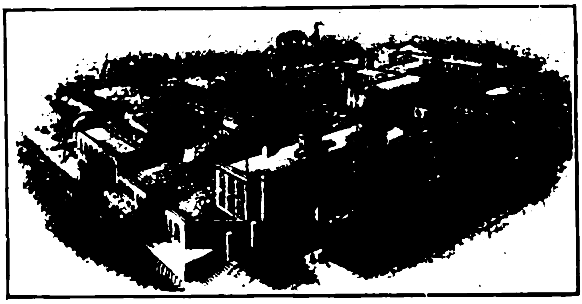
Two or Three Years' Continuous Service is Not Uncommon with these Cells. The Polarization during Use and Deterioration when Not in Use have been Reduced to a Minimum.

Write Ref. E, enclosing Trade Card, for a Free Sample for Testing.

BLUE BELL DRY CELL

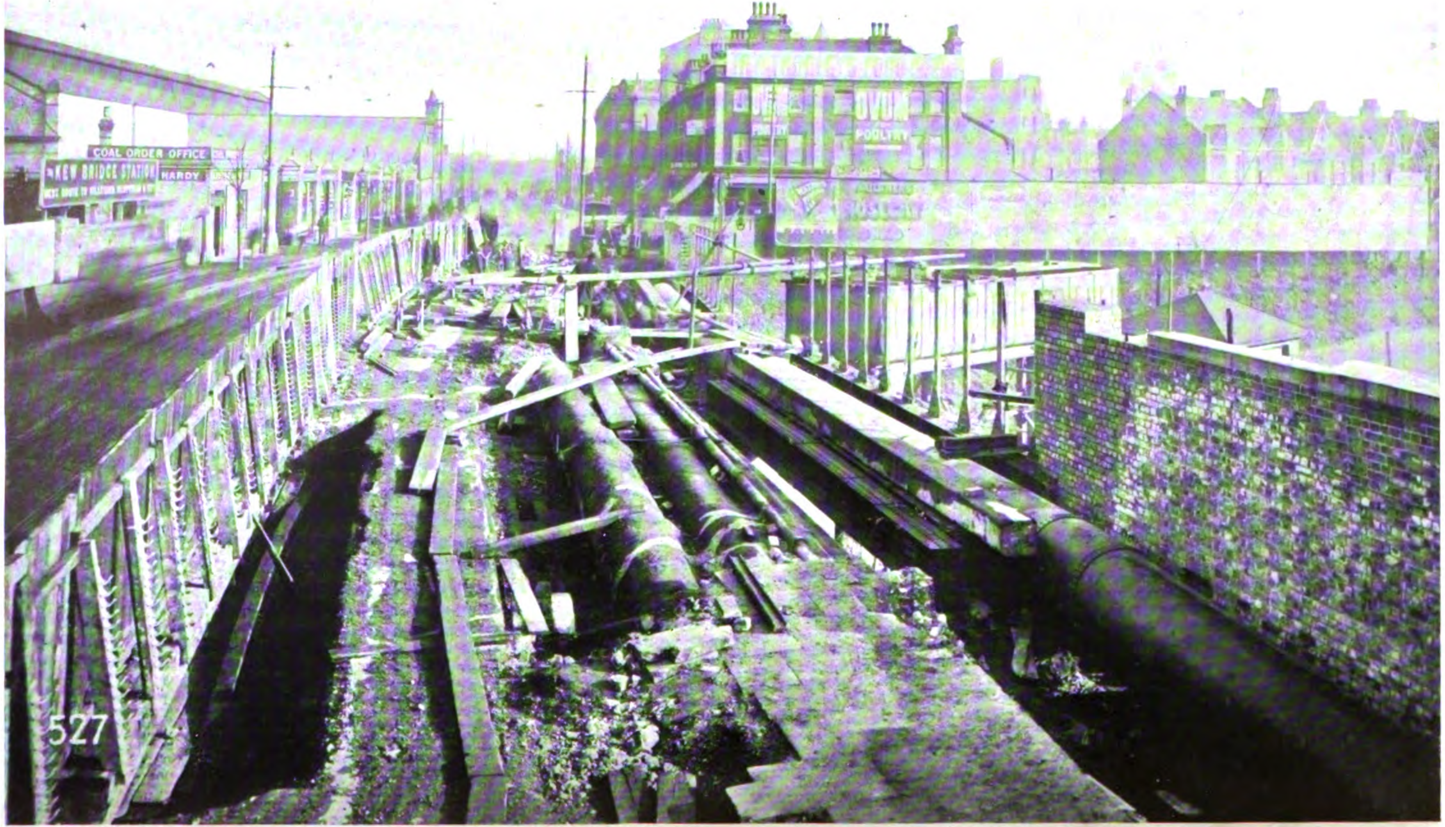
Western-Electric COMPANY, LIMITED.

Branches:
Birmingham,
Cardiff,
Glasgow,
Leeds.



And
Sydney,
Johannesburg,
Buenos Aires.

NORTH WOOLWICH WORKS, LONDON.



Diversion Work at Kew Bridge. South Side. Showing Pipes before Removal. Part of Old Footpath in Foreground. Hooks on Hoarding are to Suspend Tramway Cables.

THE
Post Office Electrical Engineers' Journal

THE DIVERSION OF UNDERGROUND PLANT.

By J. E. Gibbons,
Construction Engineer, Metropolitan South District.

THE never-ending alterations to thoroughfares in the Metropolitan Districts consequent upon street improvements, reconstruction of bridges, laying down tramway tracks, etc., impose upon the Post Office a considerable amount of work in moving and adapting existing plant to suit the new circumstances.

The number of these operations has been magnified by the vast increase in underground routes since 1900, when the telephoning of London was put in hand. So much is this the case that, it may be said, the diversions of pipes and cables has for some years been a continuous feature in the duties of some engineers, and is likely to remain so.

Unfortunately a request for a description of some diversion work at Kew came too late to permit of our obtaining photos of the active operations, yet by the courtesy of the Brentford Gas Co.'s Engineers, sufficient views, it is thought, have been procured to make matters clear.

The methods of dealing with alterations of this nature are many and varied, depending entirely upon the circumstances, and careful consideration by the engineer in charge of the work is very necessary before starting it. He should obtain all the drawings he can, ascertain how many cables exist and their description, together with the number of wires working and spare.

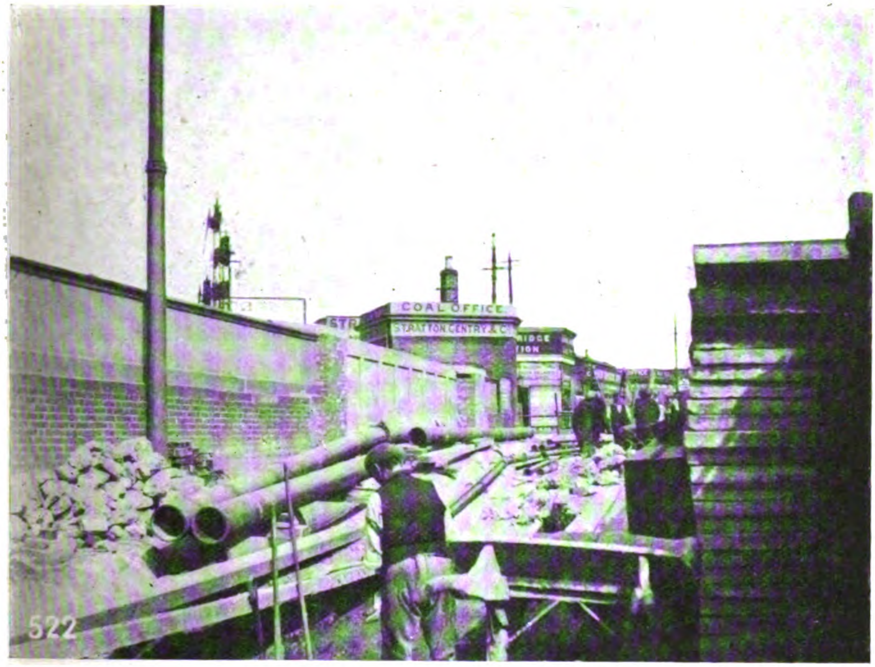
Primarily two aspects present themselves : firstly, where pipes and cables must be taken bodily away, and secondly, where the pipes and cables may be pushed over from one position to another. The former case may be further subdivided into (*a*) where the working wires can be temporarily diverted to another route between any two convenient points, and (*b*) where what are termed interruption cables are brought into use. These are generally flexible cables hung on tramway standards, on scaffold poles placed in barrels filled with earth, on the fronts of houses and shops, on trees, on fences, laid in the gutter, or on railway embankments, whichever is best, safest, and most convenient. Occasionally 14/20 (seven-pair) lead covered cables have been suspended, but generally one or more are drawn into other pipes to bring up the number of spares available for the diversion.

I.—North Side. New Pipe may be Discerned at the Foot of the Wall in Left Foreground. The Second is Underneath it. Remainder may be seen in Distance.

As regards the second method, in which the pipes and cables are pushed over bodily, the determining factors are the types of cables and possible elongation of the pipe line.

With 14/20 and similar small cables the matter is of little moment; not only are such cables readily obtained but there is generally some slack to play with. But where a main cable is affected, and the prospect of a new length having to be specially manufactured owing to elongation of the section is involved, a serious question presents itself. The main work may be held up for months; moreover it is highly desirable that the temporary interference with working wires shall be of minimum duration. No effort should therefore be spared to utilise the existing cable.

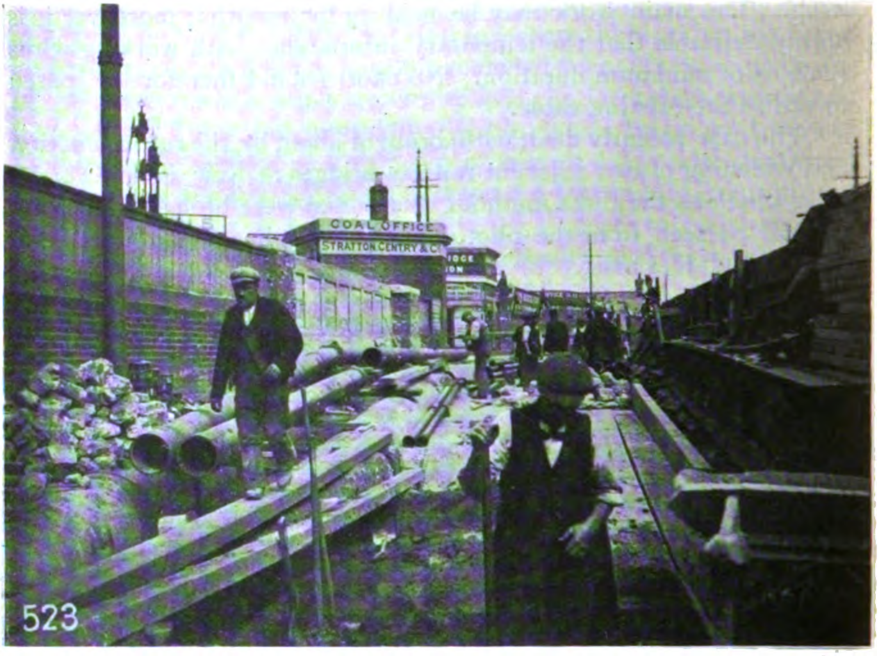
The case recently dealt with, brought about by the reconstruction and widening of two adjacent railway bridges at Kew, is noteworthy in so much as the three methods mentioned were brought into play. As will be seen from the photos, a very complicated state of affairs existed and does exist.



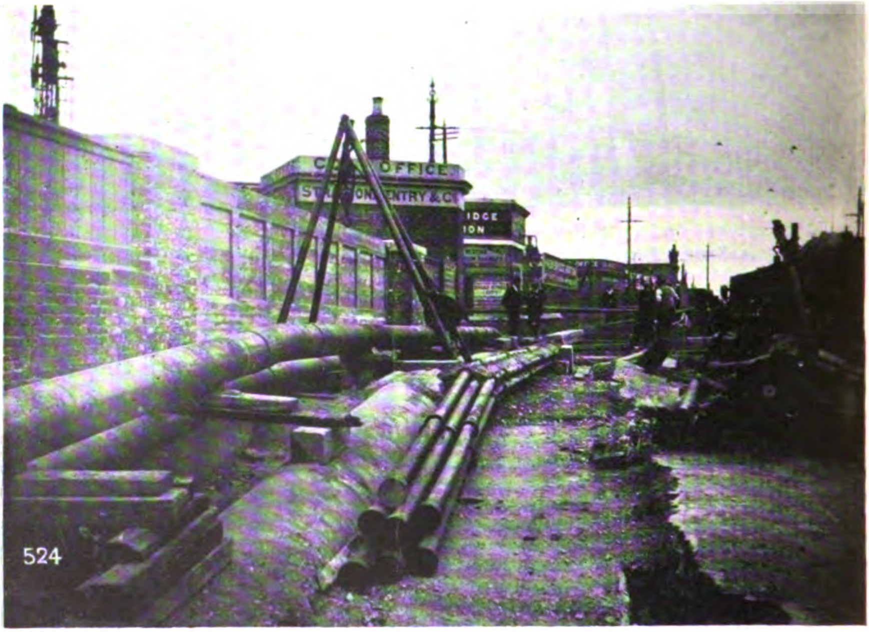
2.—North Side. Shows the Seven New Pipes in the Background in Process of Laying.

The northern foot-way was first dealt with, and it was speedily realised that the reconstruction could not be effected until the whole of the pipes and mains were removed entirely. The department had two pipes on this side, an empty $3\frac{1}{4}$ in. against the parapet, designed to carry a main cable, and an old 3 in. pipe near the kerb, carrying 4 seven-pairs, one of which turned off down the road (Lionel Road), which divides the two bridges, to serve a few local subscribers.

As regards the $3\frac{1}{4}$-in. empty pipe the removal was, of course, a simple affair. Such of the working wires in the other pipe as were "through" were diverted to the pipes on the south side, while a seven-pair from the nearest box was suspended on the tramway



3.—North Side. Interruption Cable was Suspended from Top of Coal Office to Farther Tramway Standard.

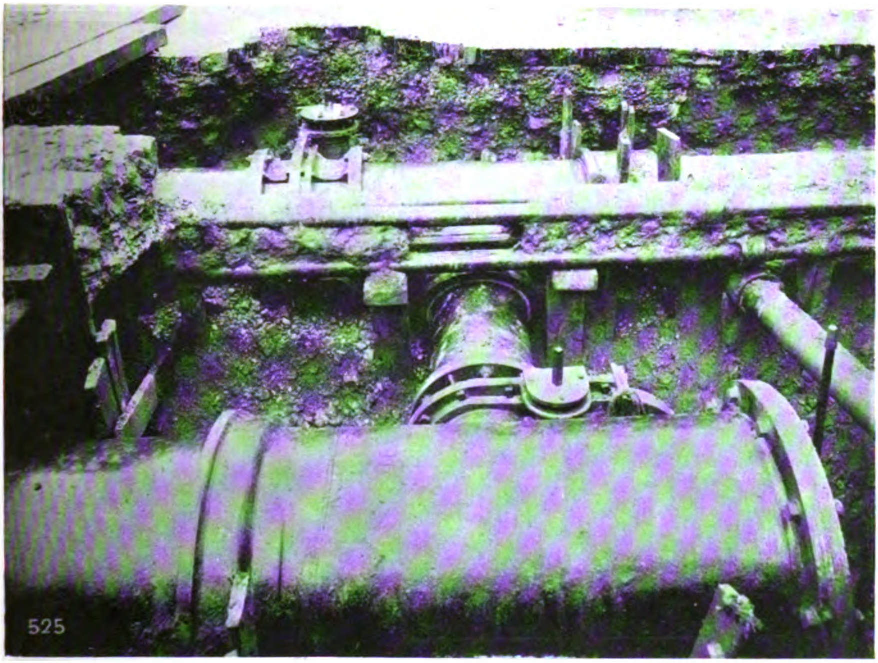


4.—North Side. A Nearer View of the Nest of Seven Pipes.

poles, and accounted for the locals in Lionel Road. The old cables were then withdrawn and the pipe recovered.

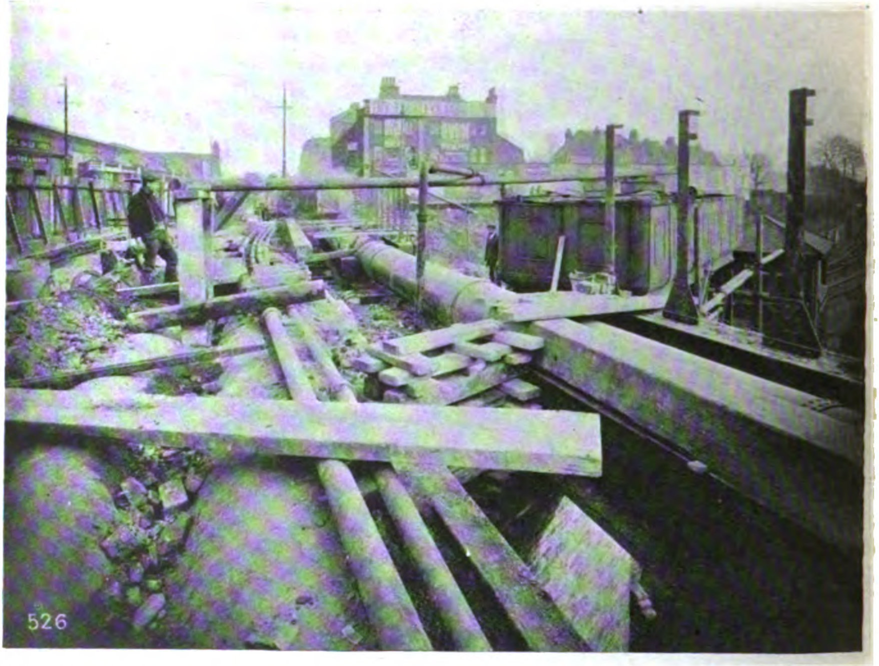
It is a good rule, when operating in a congested thoroughfare, especially when every inch of ground is eagerly sought after, to take advantage of the opportunity to lay additional pipes, and in this case authority was obtained to bring the number up to nine.

The gas and water mains having been replaced, operations were resumed. The original two pipes had to be relaid against the parapet because a huge bend on a water-main interposed between the pipe line and a junction-box which it was necessary to reach. The remaining seven pipes were laid under, or near, the kerb, and may be seen in the photographs. New manholes were built at both ends of the combined bridges, and the nine pipes were led into them. No more pipes or mains can be laid across these bridges.



5.—South Side. Shows Department's Pipes and Part of Gas Company's New Plant. The Pipes were Lifted over the Near Main.

It will thus be seen that the operations on the north side were comparatively easy. The south side called for more attention, as will appear later. The bridge was widened on this side to admit of a new footpath being formed, and the old one was converted to roadway. Here the Department had three pipes, one carrying a main trunk cable made up of $\frac{32}{200}QP + \frac{10}{200}T + \frac{32}{200}QP + \frac{16}{100}T =$ 90 wires, the second a subscribers' main cable of 800/10 wires, while the third contained sixteen 14/20 cables = 224 wires. At first everything looked rosy. The pipes were hard against the parapet of the old bridge, and, on the principle of leaving undone those things we need not do, it was calculated that the pipes, if undisturbed, or if slightly lowered, would lie against the new kerb, and consequently removal would not be necessary. A consultation on the ground with the engineers of the various authorities affected led to this idea being adopted.



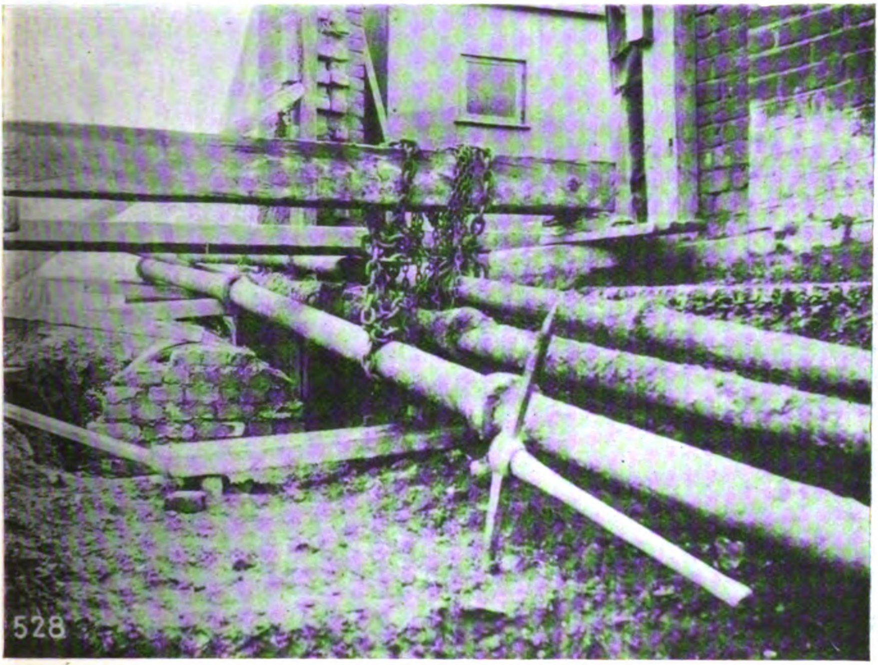
6.—South Side. Shows Pipes before Removal. Intermediate Box Near Vertical Water Pipe.

Then the trouble began. The Gas Company had made a series of expensive castings to connect their old plant to the new. It was found that one piece could not be put in so long as the Department's pipes remained in their old position. Arrangements were being made to slightly raise the Department's pipes and let the Company's main pass underneath, and a satisfactory solution had just been reached, when it was announced that the Railway Company were about to construct a "draw in"* across the footpath, at this very

* A crossing in the line of the footway to enable carts to be drawn in across the pathway.

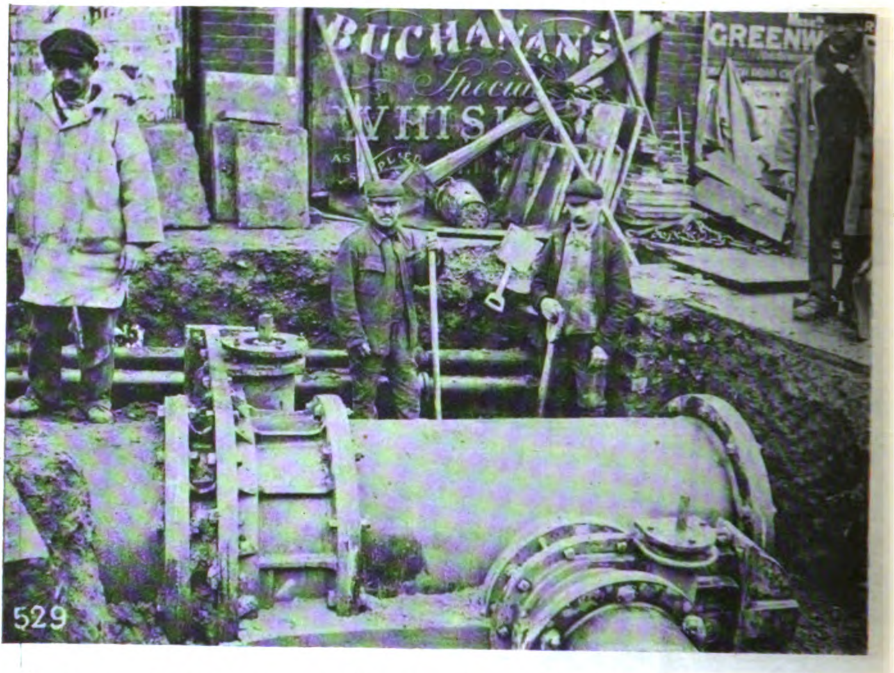
spot. This meant that by substituting 5-in. sets on 6-in. concrete, for 3-in. York, the precious headroom above the main disappeared.

Finally, a local movement created a further difficulty. The old footpath was of abnormal height to provide cover for the large gas and water mains. It was guarded on the kerb by railings to protect the public from inadvertently stepping into the deep roadway. Now these railings were largely made use of by the leisured classes of Brentford and neighbourhood to lean against and discuss things, and they had become an eyesorrow to those of the citizens who had to contribute to the upkeep of the railings. Influence was brought to bear on the authorities, and although the railings had been replaced on the north side, they were torn up again and those on the south side abandoned. The substitution of steel tubes without sockets made the lowering of the footpath possible, but it did away with the chances of letting the pipes remain, especially as the new kerb was to be stepped. There was nothing for it but to move them to a new site. The vicinity of the new parapet presented the best ground and was adopted.



7.—South Side. Pipes before Removal.

It will be evident that in works of this kind, where there are so many interests concerned, there is a risk of friction between the men of one contractor and those of another, and with the best intentions in the world it sometimes happens that one impedes another and causes disagreements. Moreover, the work is of a spasmodic character; first one firm, then another, has to take the field, so that the transport of men from a distance to carry out what may be work of an hour's duration is expensive and wasteful. A system which has largely obtained in this District, and works well, is to obtain prices on a time and material basis from the contractor who is doing the main work. He, having the labour constantly on the ground as well as materials, can generally carry out work at a moment's notice by detaching men from, say, bridge work to pipe work, and *vice-versâ.*

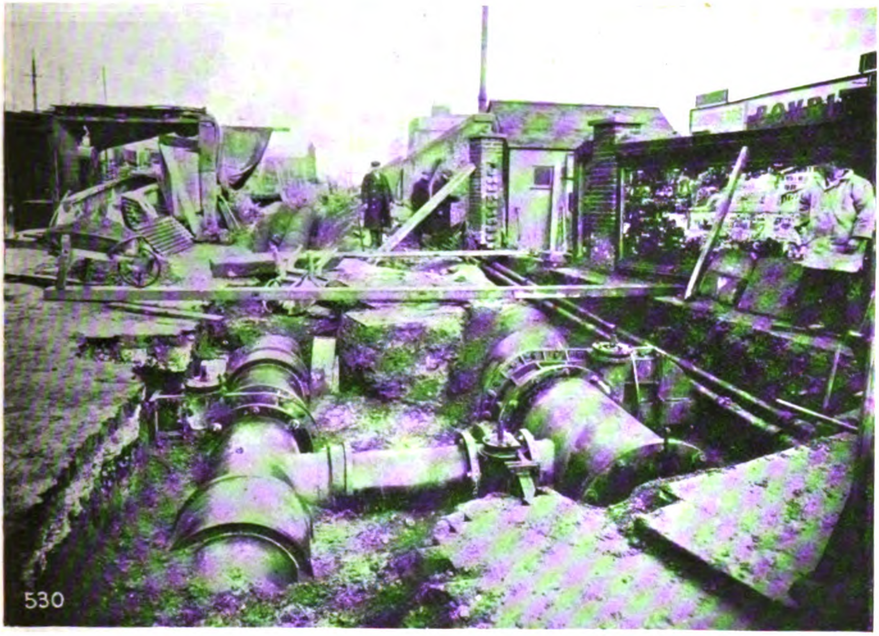


8.—SOUTH SIDE. PIPES AFTER REMOVAL, SAME SITE. THE MAN WITH THE SPADE HAS HIS BACK TO THE DEPARTMENT'S MANHOLE.

Such an arrangement was come to in this instance, and a start was made.

The pipes were laid bare all the way, and a measuring tape passed along them. The ground to be occupied was next measured and disclosed a gain of about 2 ft. No elongation here.

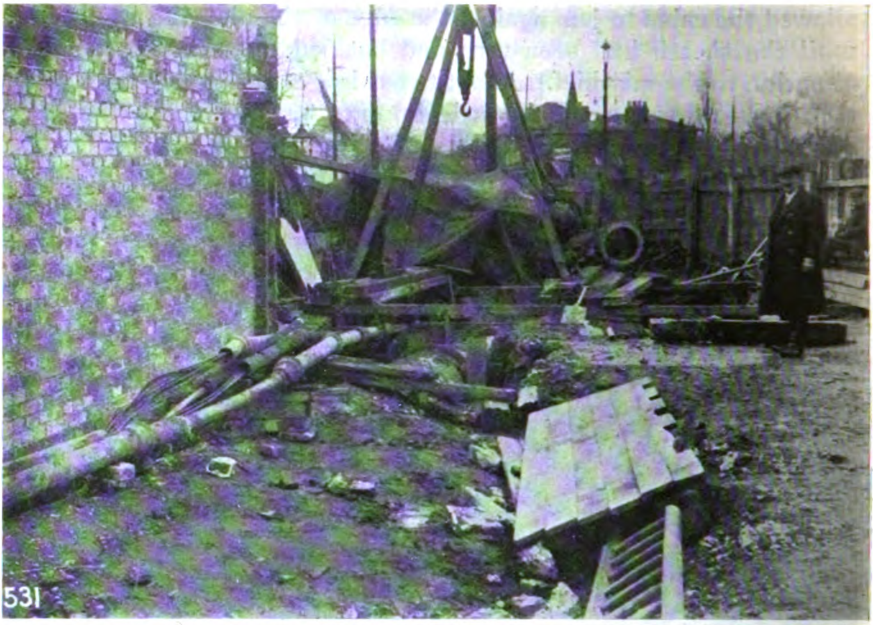
A joint box situated about midway in the section contained a joint which had a history. When the main trunk cable was being drawn in, in 1905, the men who were paying-in at the manhole allowed the cable to jam against the edge of the pipe and it was not until the sheath had been torn and buckled up that they called attention to the mischief. About two thirds of the cable length had then been drawn in. By a little irony of fortune it was the last section of an urgently wanted cable. There was the prospect of two or three months' delay if a new length was to be made, so it was decided to attempt to make the cable serve if possible. The torn portion was cut out and the ends sealed; the drawing-in was proceeded with while the balance remained on the drum. Sweep's rods were next pushed into the pipe until the sealed end was encountered. The rods were withdrawn and measured. The box in question was then cut in at the spot indicated by the rods and the balance of cable drawn in.



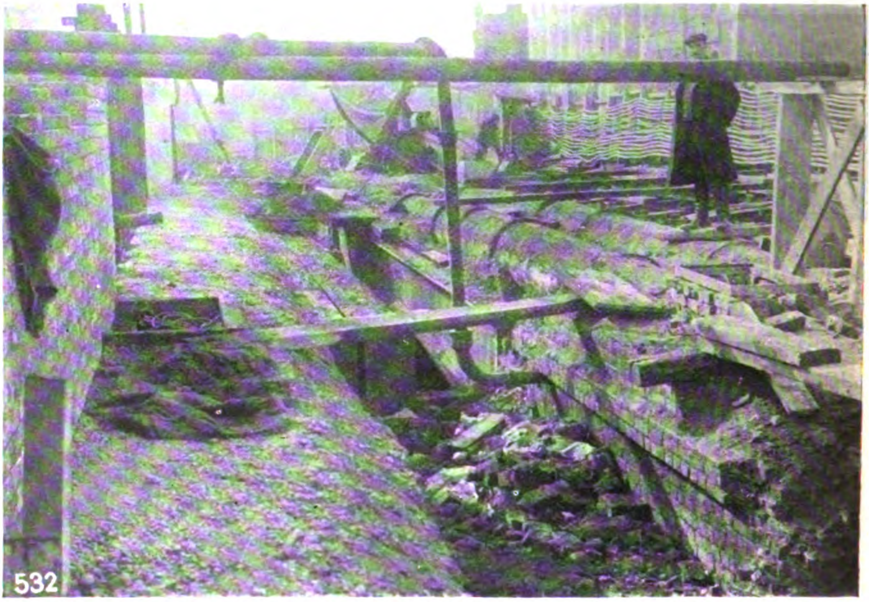
9.—SOUTH SIDE. PIPES AFTER REMOVAL. THE "DRAW-IN" WAS CONSTRUCTED WHERE THE GATEWAY IS SEEN.

Now the Department's practice in ordering main cables is to allow two yards extra on each length for waste and joints.

This surplus had been sadly diminished by the accident, and consequently the new intermediate joint had to have all the wires jointed in one place instead of distributed as in a standard joint. A short stumpy arrangement resulted. So long as it was undisturbed it acted efficiently, but it was considered it would not be safe to put the slightest strain upon it in connection with the diversion now being described.



10.—South Side. Shows Pipes after Removal with Bends Cut Out. The Mixing Board Covers Approximately the Original Site.

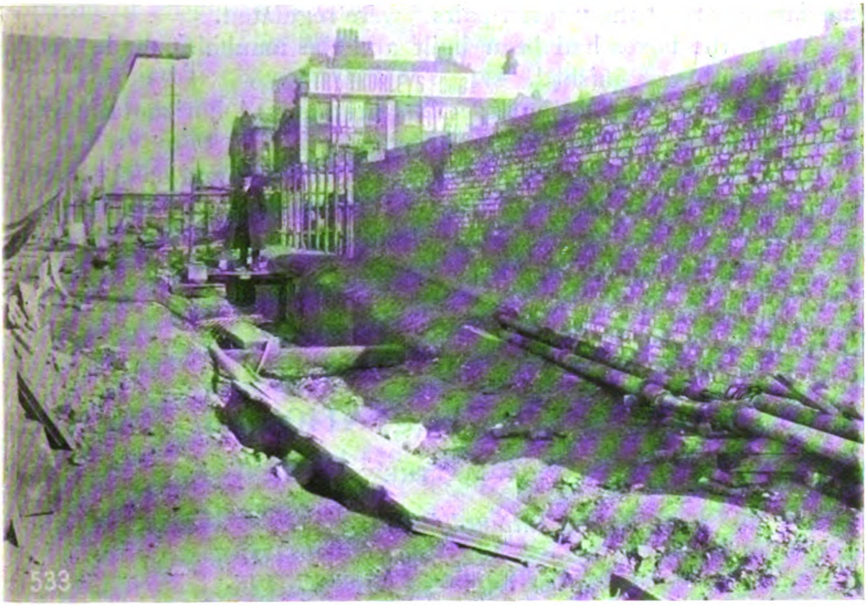


11.—South Side. Shows New Intermediate Box. Frame of Old Box can be Seen on Old Site. Tramway Interruption Cables in Background.

A flexible joint was therefore determined upon.

Sufficient 14/20 cables of suitable lengths were procured to take up the full number of wires in the trunk cable; the joint was then opened, and, the 14/20 having been slung over the plank supporting the upright water-pipe shown in **6**, the wires were teed on in the usual manner. The completed joint was carefully rubbered and was then ready.

The next point for consideration was at the western end of the bridge where the "draw-in" previously mentioned was subsequently constructed. Here were three bends, one on each pipe. It was necessary these should be cut away, because the new route was a straight one, and as this was the tightest corner in the whole affair it was decided to substitute a double junction box for them, to give greater facilities for handling the pipes, and because a sudden dip made couplings unmanageable. The whole run of the pipes having been cleared, as was said, and the vertical water-pipe temporarily removed, together with a tramway standard, the brickwork of the manholes was loosened and all was in readiness. Planks were placed across at close intervals between the old position and the new, and men with crowbars worked the pipes along, while other men, with rope slings, raised them to facilitate the movement. At each manhole and opening, wherever the cables were exposed, a



12.—South Side. Shows Pipes being Concreted in.

skilled man was stationed to watch carefully the effects upon the cables and call attention to any sign of mishap.

One by one and inch by inch the pipes were successfully moved across to their present abiding place.

As each pipe reached its destination the pipe joints were examined and the lead knocked up. One pipe, which broke owing to a defect in the casting, had the fracture cut away, and a split coupling fitted.

Attention was then directed to the cables. The flexible joint was cut away, and in consequence of the gain in length a good sound permanent joint replaced the old stumpy one. The slack of the 800/10 was distributed between the two manholes and the intermediate box, and the "seven pairs" were regulated.

When the boxes had been built and the manholes made good again the job was finished.

In a run of 260 feet the pipes had been moved horizontally over a maximum space of 8 ft. and an average of 6 ft.

On the north side 56 wires had to be handled, and on the south side 1114 wires. It is a satisfaction to record that though the operation extended over a period of nine months not a single fault on a working wire was reported.

THE DECAY AND PRESERVATION OF TIMBER.

By W. H. Matthews, B.Sc.

(*Continued from p.* 251.)

III. Methods of Preservation.

It occasionally happens that wooden objects remain intact through great lengths of time although bearing no traces of artificial preservatives, but in such cases the surroundings in which they have been placed have been of a nature to prevent the growth of fungi. Continued submersion in water or ice, or, on the other hand, freedom from moisture, is antagonistic to decay, and where such circumstances prevail, as in the case of bridge piles sunk in river beds, or of the roof timbers of well-ventilated buildings, many centuries may elapse without any noticeable change taking place. In poles planted in the ground the zone of the vulnerability is practically restricted to that portion between the ground line and two feet below it, unless radial cracks are present, which, of course, offer excellent opportunities to enterprising spores.

Long before anything was known about the mechanism of decay it was recognised that well-dried wood lasted longer than that which was left unseasoned, and that decay might be retarded or prevented by the application of certain oils and bituminous substances.

The great wooden effigy of Diana of the Ephesians was anointed with spikenard in order to ensure a permanence consistent with its alleged miràculous origin, and many archæological relics, mummy-cases and so forth, bear testimony to similar methods of treatment.

For most practical purposes oil of spikenard is now superseded by the more economical, if less fragrant, oil of tar (creosote), and to some extent by other preparations.

SEASONING.—A necessary preliminary to the application of any of these materials is a prolonged exposure of the timber to the drying action of air-currents, often followed, or replaced, by exposure to " live " steam. This process is called "seasoning."

The actual changes that take place during seasoning are not thoroughly understood, but the most important effects are the elimination of water, involving the death of the living matter in the cells, and the increased permeability of the wood.

Air-drying is the most satisfactory method of seasoning, but is one which must not be hurried. For its successful operation the timber should be stacked in open piles as soon as possible after it is stripped of its bark, and should be exposed for the full period which experience shows to be necessary for the class of timber in question, —a period of from six to nine months in the case of telegraph poles. Care has to be taken to remove not only the thick outer bark, but also the thin inner layer, for any patches of the latter remaining tend to prevent the subsequent penetration by preservatives.

Good illustrations of Post Office poles undergoing these processes are shown in Mr. Gibbon's article in Vol. 3 (Part 3) of this Journal.

Steaming or dry-heating cannot be efficiently substituted for the slower method of natural seasoning, but they are effectively employed subsequently to the latter and prior to injection in many of the various preservative processes.

IMPREGNATION PROCESSES.—For light articles, such as laths and planks used in fencing, the more or less elaborate processes of injection are not actually necessary, simple immersion or painting with some antiseptic fluid being sufficient; but for heavier timber such as poles, sleepers and mine-props, one or other of the methods described below is usually adopted.

METALLIC SALT SOLUTIONS.—Several chemical salts have been used in watery solutions for the impregnation of timber, different names being given to the process according to the salt employed, *e.g.* *Kyanising* (corrosive sublimate), *Boucherising* (copper sulphate), and *Burnettising* (zinc chloride). Of these the chief survivor is the last-named, which is extensively employed in the United States, the fluid being forced in under pressure after the timber has been seasoned, steamed for several hours, and subjected to vacuum treatment. In the *Ferrell* process the fluid, a mixture of sulphate of aluminium, the chlorides of sodium and calcium and other salts, is forced in through the *ends* of the timber.

The great disadvantage of watery solutions is naturally their tendency to leak out. Various methods for overcoming this objection have been devised, of which the following are examples:

The *Hasselman* treatment consists of boiling timber for some hours in a solution of the sulphates of copper, iron, and aluminium, with a little kainite. This is supposed to result in the combination of these salts with the cell-walls of the wood to form insoluble compounds.

The *Wellhouse* process meets the difficulty by mixing a little glue with the zinc chloride, and, after forcing the mixture into the timber, applying a solution of tannin, which combines with the glue to form an impervious "leatheroid" which blocks up the cell-openings.

In the *Allardyce* process the timber is impregnated first with zinc chloride and then with creosote, both under pressure. The creosote thus occupies the outer layers only.

In the *Card* and *Rütgers* processes an emulsion of creosote and zinc chloride is forced in, the chief distinction between the two methods being that in the former the emulsion, which is unstable in character, is kept swirling by means of a centrifugal pump, in order to prevent the two fluids from separating out. Claims have been put forward for the use of certain fluorine compounds for preservative purposes, and some of them have given very favourable results.

CREOSOTE.—In K. B. Miller's 'American Telephone Practice' appears the following: "In some quarters a process termed creosoting is meeting with favour for preserving telegraph and telephone poles." This is what one might describe as "putting it mildly"!

In this country nearly all wooden telegraph and telephone poles are creosoted before erection, and the use of creosote and other tar products for the preservation of timber in general is probably greater than that of all other timber preservatives. Both coal-tar and wood-tar yield creosotes on distillation, but that obtained from the former is the most important. Coal-tar is a by-product of coal-gas manufacture, and on re-distillation yields, in addition to pitch, a series of oils lighter than water, and another series heavier than water, the so-called "dead oils" or creosote. The chief constituents of coal-tar creosote are the *phenols* or "tar-acids" (*e. g.* carbolic acid), and aromatic hydrocarbons (naphthalene and anthracene). Unfortunately the value of some of the phenols for other purposes results in their removal from most modern creosote, thus somewhat impairing its preservative efficiency. Wood-tar creosote, with similar

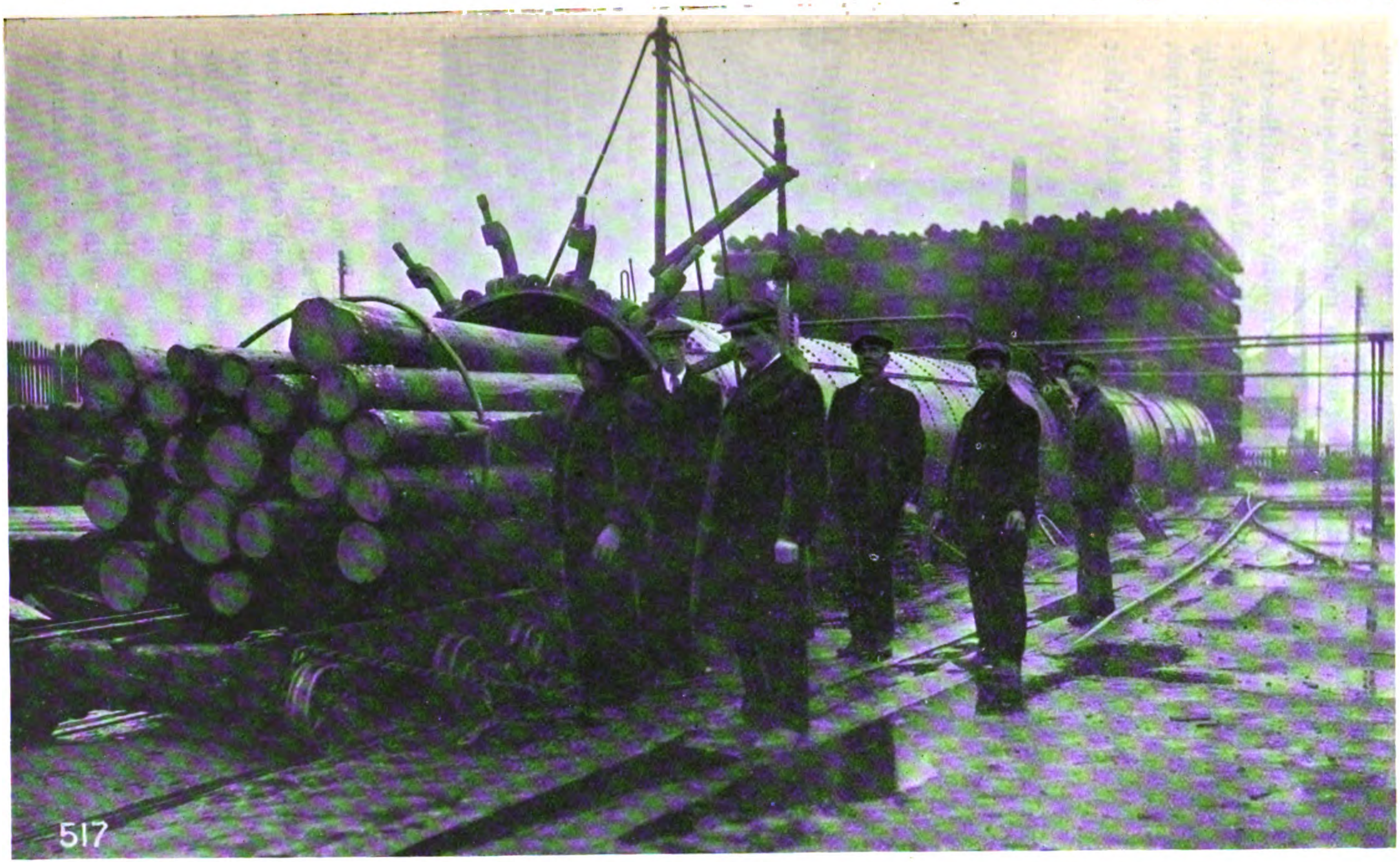


FIG. 19.—POLES BEING INSERTED IN CREOSOTING CYLINDER.

properties, but consisting almost entirely of phenols, is also used for preserving wood. Petroleum-tar creosote, a by-product of water-gas manufacture, is rarely used alone, but is mainly employed for adulterating coal-tar creosote.

Many other tar derivatives are sold under more or less descriptive trade names, such as *carbolineum*, *antigermin*, and *antipolypin*.

The methods adopted for the injection of creosote vary mainly with regard to the means for securing (1) depth of penetration, (2) economy of creosote.

The process usually employed in the case of our poles is that described by Mr. Gibbon in the article above mentioned. Briefly it consists of extracting the air from the poles in air-tight cylinders, then admitting the creosote and applying pressure in order to force it well in. **19** shows some poles entering one of the creosoting cylinders at Messrs. Burt, Boulton and Haywood's works at Silvertown, and **20** shows a general view of the creosoting yard. The pressure pumps are seen in **21**.

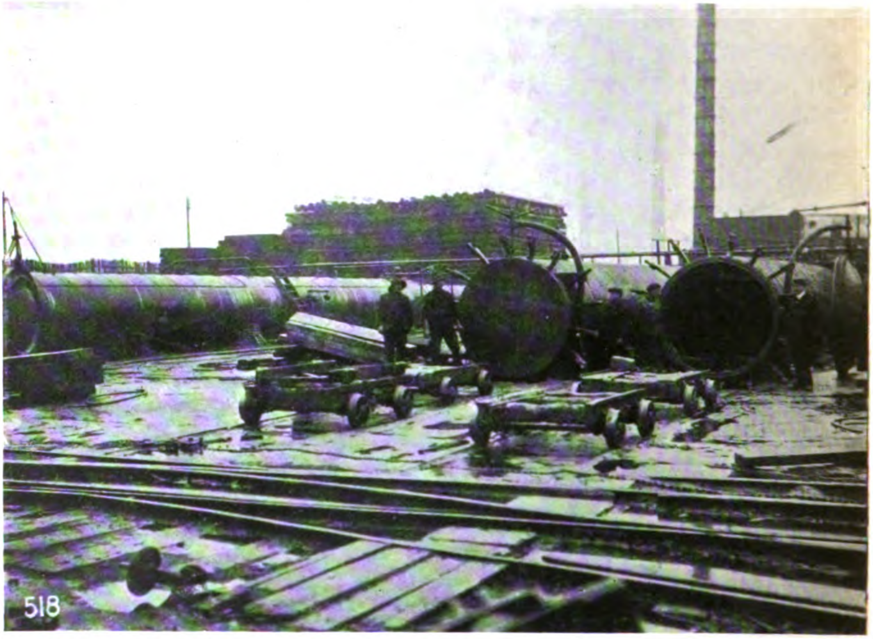


Fig. 20.—General View of a Creosoting Yard.

In the *Bethell* process, which is very similar to the above, operations are preceded by several hours' treatment with live steam at about 20 lb. pressure, the subsequent vacuum being correspondingly protracted.

The *Boulton* process, which is carried out in the cylinder shown in **22**, was devised with the object of saving time by eliminating the preliminary seasoning, that is to say, it is a "green timber" treatment. The timber is placed in creosote at a temperature slightly exceeding 212° F. for a few days. The moisture of the wood and the lighter portions of the creosote pass off as vapour and are led by means of the 6-inch pipe to a condenser. The small cylinder is for the purpose of retaining anv of the heavier oils which may be driven out of the main cylinder. When the timber has been sufficiently dehydrated pressure is applied, after which the fluid is run off. Post Office poles have occasionally been treated by this process.

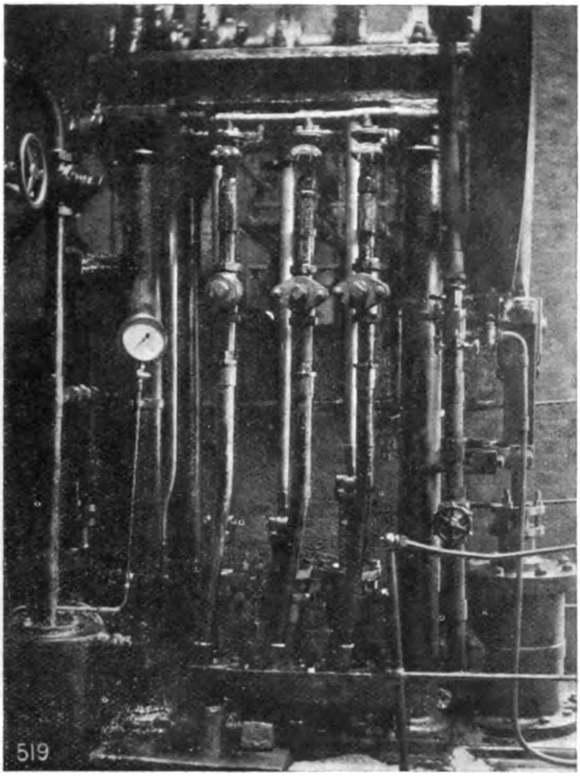


Fig. 21.—Injection Pumps.

An economy in creosote, with a proportionate lightness in the treated timber, is effected in the so-called "empty-cell" processes by sucking out some of the creosote immediately after injection, thus coating the walls of some of the cells without filling up their cavities.

The *Rüping* process is one of the most widely known of these.

After seasoning, air is forced in at a pressure of about 75 lb. to the square inch. Creosote is forced in under greater pressure, and then an air pressure of about 225 lb. is applied, thus driving the oil in to a considerable depth. When the pressure is released the compressed air in the interior of the wood drives out some of the creosote—an effect which is sometimes augmented by applying vacuum.

The *Lowry* and *A.C.W.* processes are very similar, but in the former there is no pneumatic pressure previous to the injection, the surplus oil being abstracted by powerful suction pumps, whilst in the latter there is a preliminary steaming and an air-pressure is applied after the oil is run off. In contrast to all these "pressure" processes are the open bath treatments, in some of which, *e.g.* the *Guissani* process, a certain amount of atmospheric pressure is utilised by first heating the wood, either in an oven or in a hot fluid, and then plunging it into cold creosote.

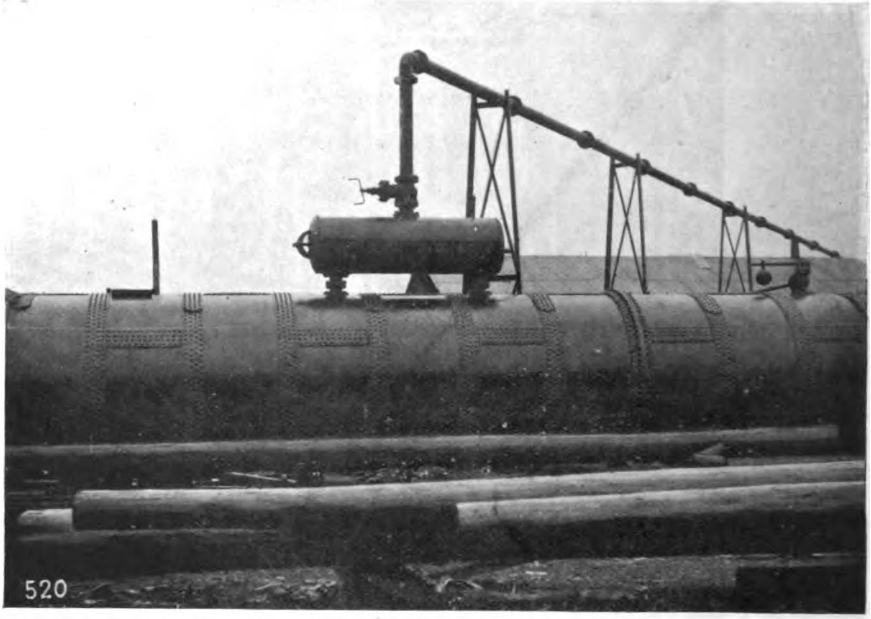


Fig. 22.—Injection Cylinder used in "Boulton" Process.

At the Paris Conference in 1910 a paper was contributed by a Hungarian delegate describing a method adopted in Hungary for aiding penetration of the oil, in the case of pitch-pine poles, by stabbing the poles spirally by means of a suitable machine.

For injecting paving blocks a mixture of resin and creosote is often used, dry heat being applied before the injection under pressure takes place. Creosoted timber is never subject to organic decay, but it may be worn away by mechanical means. The explanation of the occasional occurrence of fungi in creosoted poles is that the oil rarely penetrates much beyond the sapwood. Thus, if spores gain entrance to the heartwood by means of pole slots or cracks formed after injection, they may germinate and in time destroy the heartwood.

In such cases, however, as Mr. Henley pointed out at the Paris Conference, the creosoted ring of sapwood usually possesses all the necessary strength and stiffness.

TREATMENT OF INFECTED TIMBER.—It is, as a rule, safest to reject a piece of timber which on being sawn shows the red stripes which denote the presence of the dry-rot fungus, but a thorough seasoning may prevent any further development. Even when the presence of destructive fungi is discovered in wood which forms part of a building, it may not be necessary to replace any part of the structure if the decay has not advanced very far, for in the early stages the fungi can be destroyed by heating or by the application of carbolic acid or some other strong antiseptic. A temperature of about 40° C. maintained for an hour or so is fatal to most fungi, including that of dry-rot, but there are a few that can resist much higher degrees of heat. When decay has reached an advanced stage it is necessary to remove every piece of infected or suspected timber and to treat all the neighbouring woodwork with a strong antiseptic. Thorough ventilation should also be secured if possible. It is usually noticed that wood adjoining the walls of buildings or reposing upon "pugging" (deadening material) is the first to be attacked. This is owing to the favourable conditions for the germination and growth of fungus spores provided by the moisture and calcium bicarbonate from the mortar and by the lack of ventilation. It may be mentioned that washed gravel is a much better filling-in material than cinders, inasmuch as it retains far less moisture.

MISCELLANEOUS NOTES.—*Harmless fungi.*—When timber has been stored in yards for some time there often appear on it species of fungi belonging to the groups known as "moulds" and "mildews," some of which may cause black or blue stains. These fungi live upon the contents of the cells, but do not attack the substance of the cell-walls.

Thus they do not cause any real injury to the timber, although they may lessen its selling value.

Bacteria.—These minute organisms have many characters in common with the fungi, but are all of microscopic dimensions. Some of them are always found associated with the decay of other organisms, and it is probable that some species are to a certain extent concerned in the decay of timber, but they have not yet been specifically determined. At any rate the damage caused by them is negligible in comparison with that due to fungi.

Eremacausis.—This word was introduced by *Liebig* in the early part of last century to denote that decay which he took to be a process of slow combustion, independent of living organisms. It was long ago shown that his view was untenable, as the process in question is arrested by antiseptics, but the term still finds place in a certain standard text-book of telegraphy.

Winter felling.—The department specifies that its poles shall be felled in the winter months. It is often stated that timber felled in winter "when the sap is down" is less liable to dry-rot than that felled in summer, and a long controversy was waged involving many learned and ingenious arguments as to the reason for this, until it was finally demonstrated that the assertion was contrary to fact. Wood felled when the sap is up of course takes longer in seasoning because it contains more moisture, but when properly seasoned it is no more liable to attack than that felled in winter.

Selected literature.—The best English summary of recent years on the destruction of wood by fungi is the paper in 'Science Progress' for January, 1909, by A. H. R. Buller, who has also published several important papers in the 'Journal of Economic Biology' and elsewhere.

The United States Department of Agriculture has devoted particular attention to the subject and has brought out a fine series of bulletins, many of which are profusely illustrated and all of which are extremely useful.

Those of particular interest are Bulletins 6, 13, 22, 41 and 78 of the Forestry Division and No. 14 of the Bureau of Plant Industry.

The English Board of Agriculture issues *gratis* a small pamphlet (Leaflet No. 113) on the dry rot.

Good introductory books on the decay of timber are those by Hartig ('Text-book of the Diseases of Trees,' English translation, 1894) and Marshall Ward ('Timber and some of its Diseases,' 1897), whilst some of the engineering books on timber, *e.g.* Laslett's, contain interesting chapters on the subject.

'Le Bois,' by J. Beauverie (Paris, 1905), goes into the matter pretty fully, as do several German works, some of which treat the question of dry rot from its botanical, chemical, architectural, biological, hygienic, and even legal aspects!

That by Dr. Carl Mez (Berlin, 1908) gives a full classification of all known domestic wood-destroying fungi and is well illustrated. B. Malenković (Vienna, 1907) treats the subject of wood preservation in an exhaustive manner, particularly from the chemical aspect.

A useful illustrated summary by three German professors was published in Berlin in 1910 under the characteristic German title, "Der Hausschwamm und die wichtigsten Trockenfaüleschwämme vom botanischen, bautechnischen und juristischen Standpunkte."

With regard to the antiseptic treatment of timber, Sir S. B. Boulton's paper, read before the Institution of Civil Engineers in May, 1884, is still a standard classic, and was reprinted, together with the full discussion and an introduction by the author, in 1910.

The present article is merely an introductory sketch, but it is hoped that it will arouse interest in some of the more elaborate and original works enumerated above, the perusal of which will dispel any suggestion that the study of the decay of timber is entirely a matter of "dry rot."

My thanks are due to Mr. G. Morgan, I.S.O., Controller of Stores, and to Messrs. Burt, Boulton and Haywood, Ltd., of Silvertown, in connection with the photographs reproduced in the present number.

INDUCTANCE OF TELEGRAPH APPARATUS.

ALTHOUGH values of the electrical constants of the apparatus used by the Post Office have from time to time appeared in various publications, it is found that owing to the adoption of new types of circuits and other modern developments, further and more exhaustive measurements are now desirable, and accordingly the Research Branch of the Engineering Department of the Post Office has undertaken the work.

The measurements of the inductance of telegraph apparatus have been completed, and the results are given herewith.

The method used is that shown in the diagram, generally known as Anderson's method.

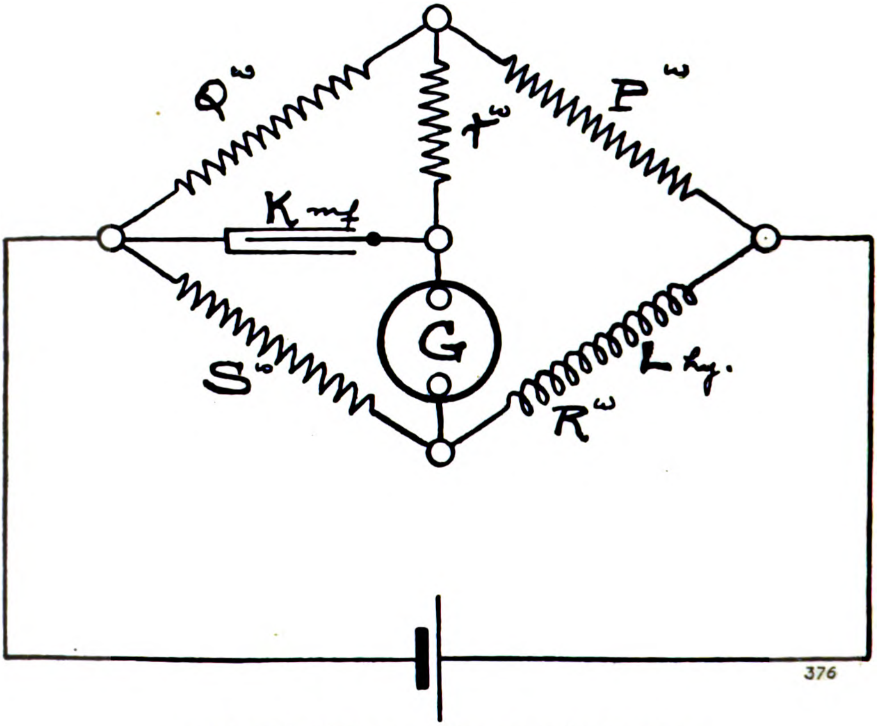
The bridge is first balanced for resistance in the ordinary manner. The battery and galvanometer keys are then depressed in the reverse order, and K and r varied till no kick is produced on the galvanometer. When this condition has been obtained the inductance is given by the following formula:

$$L = \frac{K}{10^6}\left[r(R + S) + RQ\right].$$

The proof of this formula will be found in 'Electrical Laboratory Notes,' No. 47, and also in 'A Handbook for the Electrical Laboratory,' vol. ii, p. 192, both by Dr. J. A. Fleming.

It will be observed that the inductance of any particular instrument is not constant, but tends towards a maximum. In several cases the maximum has been passed, and the inductance thereafter decreases as the current is increased. This is due to the permeability of the iron cores decreasing when the flux becomes large; in fact, the permeability and the inductance vary together.

It will also be noticed that the inductance obtained with differentially wound instruments, when the coils are joined in series, is always about four times that obtained with the same instrument when the coils are joined in parallel. With the coils in series the effective number of turns is twice that when the coils are in parallel,



Anderson's Method of Measuring Inductance.

and since the inductance varies as the square of the number of turns the above result follows at once.

The fact that the inductance with the coils in series is not exactly four times that with the coils in parallel is due to the presence of the iron cores and also to magnetic leakage.

Attention is drawn to the change in inductance produced by the movement of the armature of sounders and similar instruments.

It would be very instructive to reproduce the curves which have been plotted from the results given, but unfortunately space does not permit.

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Relay Standard A, 200^{ω} + 200^{ω}; coils in parallel	10	·78	—
	20	·83	
	30	·87	
	40	·89	
Relay Standard A, 200^{ω} + 200^{ω}; coils in series	5	3·12	—
	10	3·36	
	15	3·46	
	20	3·55	
Relay Standard B, 100^{ω} + 100^{ω}; coils in parallel	5	·72	—
	10	·79	
	15	·80	
	20	·83	
	30	·86	
	40	·90	
	50	·91	
	60	·92	
	80	·95	
	100	·95	
	120	·95	
	140	·97	
Relay Standard B, 100^{ω} + 100^{ω}; coils in series	5	3·32	—
	10	3·50	
	15	3·62	
	20	3·74	
	30	3·80	
	40	3·87	
	50	3·92	
	60	3·92	
	80	3·92	
	100	3·92	
	120	3·92	
	140	3·92	
Relay N.P.B., 200^{ω} + 200^{ω}; coils in parallel	20	·76	—
	40	·78	
	60	·79	
	80	·80	
Relay N.P.B., 200^{ω} + 200^{ω}; coils in series	10	3·00	—
	20	3·16	
	30	3·20	
	40	3·24	
	50	3·29	
Relay N.P.C., 100^{ω} + 100^{ω}; coils in parallel	20	·74	—
	40	·75	
	60	·77	
	80	·78	

INDUCTANCE OF TELEGRAPH APPARATUS.

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Relay N.P.C., 100^{ω} + 100^{ω}; coils in series	10	2·97	—
	20	3·05	
	30	3·08	
	40	3·11	
	50	3·11	
Relay N.P.C., 500^{ω} + 500^{ω}; coils in parallel	20	4·47	—
	40	4·71	
	60	4·75	
	80	5·02	
Relay N.P.C., 500^{ω} + 500^{ω}; coils in series	10	17·75	—
	20	18·19	
	30	18·96	
	40	19·76	
	50	19·87	
Relay Baudot, 200^{ω}	5	1·14	—
	10	1·21	
	15	1·23	
	20	1·26	
	30	1·26	
	40	1·28	
	50	1·31	
	60	1·33	
	80	1·33	
	100	1·33	
	120	1·33	
	140	1·33	
Relay I.N.P., 500^{ω} + 500^{ω}; coils in parallel	2	1·17	—
	4	1·46	
	6	1·52	
	8	1·54	
	10	1·57	
	12	1·60	
Relay I.N.P., 500^{ω} + 500^{ω}; coils in series	2	5·18	—
	4	6·17	
	6	6·44	
	8	6·70	
	10	6·79	
	12	6·79	

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Relay I.N.P., 10^ω + 10^ω; coils in series	20	·214	—
	30	·220	
	40	·224	
	50	·227	
	60	·230	
	80	·232	
	100	·230	
	120	·227	
	140	·225	
	160	·225	
Relay P.I.B., 500^ω + 500^ω; coils in parallel	2	1·27	—
	4	1·39	
	6	1·50	
	8	1·58	
	10	1·64	
	12	1·67	
Relay P.I.B., 500^ω + 500^ω; coils in series	2	5·60	—
	4	6·31	
	6	6·58	
	8	6·94	
	10	7·12	
	12	7·39	
Receiver Wheatstone, 100^ω + 100^ω; coils in parallel	5	·70	—
	10	·76	
	20	·84	
	30	·89	
	40	·92	
	50	·94	
Receiver Wheatstone, 100^ω + 100^ω; coils in series	3	2·99	—
	5	3·23	
	10	3·54	
	15	3·65	
	20	3·78	
	30	3·90	
Sounder, 20^ω; armature up	60	·15	Gap between armature and magnet cores = 16 mils.
	80	·18	
	100	·18	
	120	·18	
Sounder, 20^ω; armature down	60	·24	Gap between armature and magnet cores = 9 mils.
	80	·24	
	100	·24	
	120	·24	

INDUCTANCE OF TELEGRAPH APPARATUS.

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Sounder, 900^{ω} ; armature up	10	16·67	Gap between armature and magnet cores = 16 mils.
	20	18·28	
	30	18·29	
	40	17·11	
Sounder, 900^{ω} ; armature down	10	23·51	Gap between armature and magnet cores = 9 mils.
	20	23·11	
	30	20·31	
	40	18·75	
Sounder polarised A, 100^{ω} + 100^{ω} ; coils in parallel	10	·65	Inductance the same for equal values of marking and spacing currents.
	15	·67	
	20	·69	
	25	·72	
	30	·73	
	40	·74	
	50	·75	
Sounder polarised A, 100^{ω} + 100^{ω} ; coils in series	5	2·61	Inductance the same for equal values of marking and spacing currents.
	10	2·86	
	15	2·92	
	20	3·04	
	25	3·10	
	30	3·16	
Sounder polarised D, 100^{ω} + 100^{ω} ; single coil, armature up	2·5	·34	Inductance the same for equal values of marking and spacing currents. Gap = 16 mils.
	4	·35	
	6	·36	
	8	·36	
	10	·37	
	15	·40	
	20	·41	
Sounder polarised D, 100^{ω} + 100^{ω} ; single coil, armature down	2·5	·36	Inductance the same for equal values of marking and spacing currents. Gap = 9 mils.
	4	·36	
	6	·37	
	8	·39	
	10	·40	
	15	·43	
	20	·45	
Sounder polarised D, 100^{ω} + 100^{ω} ; coils in series, armature up, spacing current	2·5	1·37	Gap = 16 mils.
	4	1·44	
	6	1·54	
	8	1·60	
	10	1·64	
	15	1·78	
	20	1·85	

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Sounder polarised D, 100$^{\omega}$ + 100$^{\omega}$; coils in series, armature up, marking current	2·5	1·37	Gap = 16 mils.
	4	1·44	
	6	1·52	
	8	1·56	
	10	1·61	
	15	1·73	
	20	1·80	
Sounder polarised D, 100$^{\omega}$ + 100$^{\omega}$; coils in series, armature down, spacing current	2·5	1·47	Gap = 9 mils.
	4	1·54	
	6	1·64	
	8	1·70	
	10	1·78	
	15	1·92	
	20	2·05	
Sounder polarised D, 100$^{\omega}$ + 100$^{\omega}$; coils in series, armature down, marking current	2·5	1·47	Gap = 9 mils.
	4	1·51	
	6	1·61	
	8	1·68	
	10	1·76	
	15	1·90	
	20	2·00	
Sounder polarised D, 500$^{\omega}$ + 500$^{\omega}$; single coil, armature up	2·5	1·80	Inductance the same for equal values of marking and spacing currents. Gap = 16 mils.
	4	1·90	
	6	1·95	
	8	1·98	
	10	2·02	
	15	2·07	
	20	2·12	
Sounder polarised D, 500$^{\omega}$ + 500$^{\omega}$; single coil, armature down	2·5	1·98	Inductance the same for equal values of marking and spacing currents. Gap = 9 mils.
	4	2·10	
	6	2·17	
	8	2·22	
	10	2·27	
	15	2·34	
	20	2·35	
Sounder polarised D, 500$^{\omega}$ + 500$^{\omega}$; coils in series, armature up	2·5	7·68	Inductance the same for equal values of marking and spacing currents. Gap = 16 mils.
	4	7·77	
	6	8·04	
	8	8·13	
	10	8·31	
	15	8·49	
	20	8·49	

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Sounder polarised D, 500^{ω} + 500^{ω} ; coils in series, armature down	2·5	8·31	Inductance the same for equal values of marking and spacing currents. Gap = 9 mils.
	4	8·84	
	6	9·02	
	8	9·20	
	10	9·39	
	15	9·66	
	20	9·74	
Sounder polarised D, 2000^{ω} ; armature up, spacing current	2	12·83	Gap = 16 mils.
	5	13·84	
	10	14·65	
	15	15·26	
	20	15·45	
Sounder polarised D, 2000^{ω} ; armature up, marking current	2	12·83	Gap = 16 mils.
	5	13·50	
	10	13·98	
	15	14·05	
	20	14·05	
Sounder polarised D, 2000^{ω} ; armature down, spacing current	2	14·05	Gap = 9 mils.
	5	14·83	
	10	15·87	
	15	16·48	
	20	16·48	
Sounder polarised D, 2000^{ω} ; armature down, marking current	2	14·05	Gap = 9 mils.
	5	14·47	
	10	14·96	
	15	15·26	
	20	15·26	
Sounder polarised D, 4500^{ω} ; armature up, spacing current	2	18·36	Gap = 16 mils.
	4	19·46	
	6	20·58	
	8	21·22	
	10	21·90	
	15	23·20	
	20	23·88	
Sounder polarised D, 4500^{ω} ; armature up, marking current	2	18·36	Gap = 16 mils.
	4	19·25	
	6	19·90	
	8	20·58	
	10	20·79	
	15	21·68	
	20	21·90	

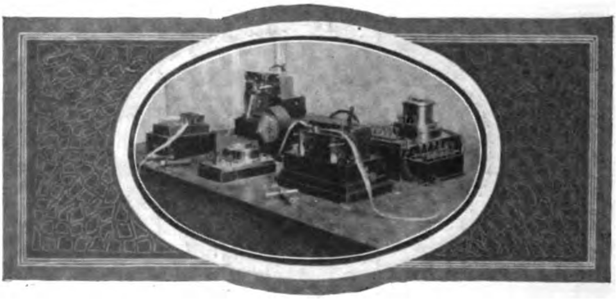
Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Sounder polarised D, 4500^{ω}; armature down, spacing current	2	17·70	Gap = 9 mils.
	4	21·22	
	6	22·11	
	8	23·20	
	10	24·10	
	15	25·63	
	20	26·75	
Sounder polarised D, 4500^{ω}; armature down, marking current	2	17·70	Gap = 9 mils.
	4	20·80	
	6	21·45	
	8	22·10	
	10	22·52	
	15	23·20	
	20	23·41	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in parallel, armature up, spacing current	10	1·46	Gap = 12 mils.
	20	1·64	
	30	1·72	
	50	1·80	
	70	1·83	
	100	1·86	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in parallel, armature up, marking current	10	1·46	Gap = 12 mils.
	20	1·55	
	30	1·61	
	50	1·64	
	70	1·64	
	100	1·66	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in parallel, armature down, spacing current	10	1·58	Gap = 7 mils.
	20	1·75	
	30	1·83	
	50	1·95	
	70	2·03	
	100	2·08	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in parallel, armature down, marking current	10	1·55	Gap = 7 mils
	20	1·64	
	30	1·69	
	50	1·75	
	70	1·75	
	100	1·78	

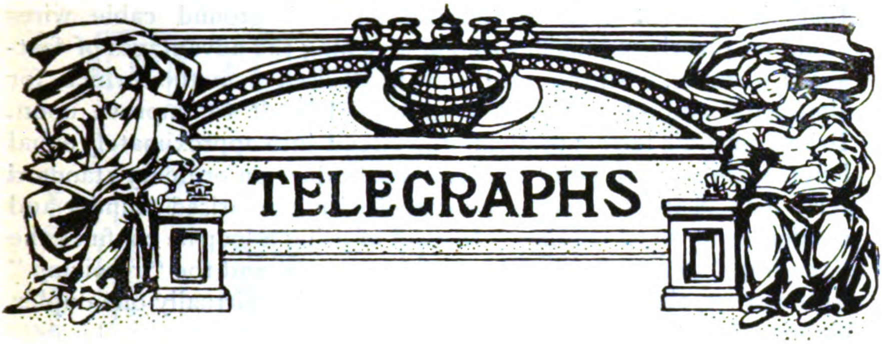
Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in series, armature up, spacing current	2	5·08	Gap = 12 mils.
	5	5·64	
	10	6·12	
	15	6·44	
	20	6·60	
	30	7·00	
	40	7·08	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in series, armature up, marking current	2	5·00	Gap = 12 mils.
	5	5·48	
	10	5·80	
	15	6·04	
	20	6·12	
	30	6·20	
	40	6·36	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in series, armature down, spacing current	2	5·40	Gap = 7 mils.
	5	5·96	
	10	6·44	
	15	6·84	
	20	7·16	
	30	7·40	
	40	7·80	
Sounder polarised, relaying, $500^{\omega} + 500^{\omega}$; coils in series, armature down, marking current	2	5·32	Gap = 7 mils.
	5	5·80	
	10	6·20	
	15	6·36	
	20	6·60	
	30	6·68	
	40	6·68	
Transformer, 7-terminal, primary P	10	·327	—
	20	·346	
	40	·379	
	60	·432	
Transformer, 7-terminal, primary P1	10	·362	—
	20	·397	
	40	·527	
	60	·573	
Transformer, 7-terminal, P and P1 in series	10	1·67	—
	20	1·77	
	40	2·10	
	60	2·22	

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Transformer, 7-terminal, secondary	10	2·95	—
	20	3·49	
	40	4·09	
	60	4·33	
Transformer, 7-terminal; all coils in series and assisting each other magnetically	10	9·68	—
	20	11·79	
	40	12·79	
	60	11·68	
	80	9·66	
Transformer, 7-terminal; all coils in series, but secondary coil opposing the primary coils magnetically	10	·402	—
	20	·402	
	40	·459	
	60	·574	
Transformer, 7-terminal; mutual inductance between secondary coil and both primary coils	10	2·32	—
	20	2·85	
	40	3·08	
	60	2·77	
Coil bridging, type 2, 3000^{ω}	2	3·90	—
	5	4·94	
	10	5·92	
	20	6·30	
	30	6·30	
	37	6·06	
Coil bridging, 1000^{ω}	5	12·68	—
	10	15·35	
	15	15·55	
	20	15·10	
	40	11·94	
	60	9·81	
	80	7·61	
	100	6·75	
Bell magneto, 100^{ω}	2	1·96	—
	5	2·28	
	10	2·52	
	15	2·68	
	20	2·84	
Bell magneto, 1000^{ω}	2	11·99	—
	5	14·23	
	10	17·36	
	15	19·15	
	20	19·60	

INDUCTANCE OF TELEGRAPH APPARATUS.

Apparatus.	Current (milli-ampères).	Inductance (henrys).	Remarks.
Indicator N.P., 100ω	5	2·93	—
	10	3·25	
	20	3·62	
	30	3·78	
	40	3·94	
Indicator N.P., 1000ω	2	2·86	—
	5	3·62	
	10	4·16	
	15	4·40	
	20	4·49	
Indicator A. B. C., 500ω + 500ω ; coils in parallel	2	2·57	—
	5	3·34	
	10	4·36	
	15	4·90	
	20	5·16	
Indicator A. B. C., 500ω + 500ω ; coils in series	2	14·21	—
	5	18·45	
	10	20·45	
	15	21·57	
	20	21·77	





TELEGRAPHS

FAST-SPEED WHEATSTONE WORKING ON UNDERGROUND CABLE CIRCUITS.

By A. FRASER.

IN these days of type-printing telegraph systems it may seem somewhat incongruous to place in competition with them again one system which has of late years fallen much into neglect, but which, with the conditions that now obtain, will emerge from its comparative obscurity and re-assert itself as the most effective agent in dealing with the great mass of the inter-urban traffic of the Kingdom.

To avoid its use hitherto, a large number of channels, worked at low speeds, have been brought into use. But this increase in the number of channels must stop somewhere, and to-day difficulty is already being experienced in obtaining spare wires in the underground cables. Obviously, therefore, if the number of channels remains constant and the need for more increases, the slower outlets must be shut down and the work confined to a fewer number of fast-speed circuits with suitable staff to meet the requirements.

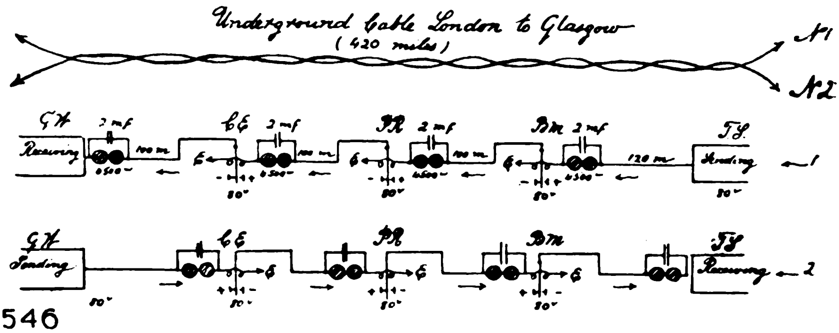
Unfortunately, however, the electrical conditions that obtain in underground cables are unfavourable to fast-speed working; so much so, that on a direct London–Glasgow circuit it is doubtful if a higher speed than forty words a minute could be obtained.

In a paper recently contributed to the JOURNAL, some interesting details were given showing to what extent the system enabled existing circuits to be dispensed with. But essential to all fast-speed working is the presence of a complicated repeater at some point in the underground circuit, which is not only costly in itself, but also requires frequent—at times continuous—attention from an experienced officer at the place where it is installed.

Now it occurred to Mr. C. C. Vyle—to whom the Department is already indebted for many contributions to practical telegraphy—

that the present type of repeater on underground cable wires could be greatly modified without lessening the advantages of fast-speed working, with the result that he devised a method which for simplicity and efficiency it would be difficult to improve upon. Briefly put, his idea is to divide the circuit into approximately equal lengths, and at each point of division introduce an ordinary standard relay for repeating purposes associated with a polarised sounder and condenser for local reading. Instead of using a loop he confines the "sending" to one of the wires forming a pair, and the "receiving" to the other, the two independent lines forming virtually one duplex circuit (1).

Having outlined his system and proved its practicability on experimental loops, arrangements were made for a working trial on a London–Glasgow circuit having repeaters at Birmingham, Preston, and Carlisle, the working voltage at each point being 80 volts and the current 14 milliampères. When the repeaters had been installed at the several points of this long circuit (420 miles of underground), it was found that a satisfactory speed of 200 words per minute simplex (with the means of stopping the sending station when necessary) was obtainable between London and Glasgow.



I.—Skeleton Diagram of Circuit with Repeater Stations.

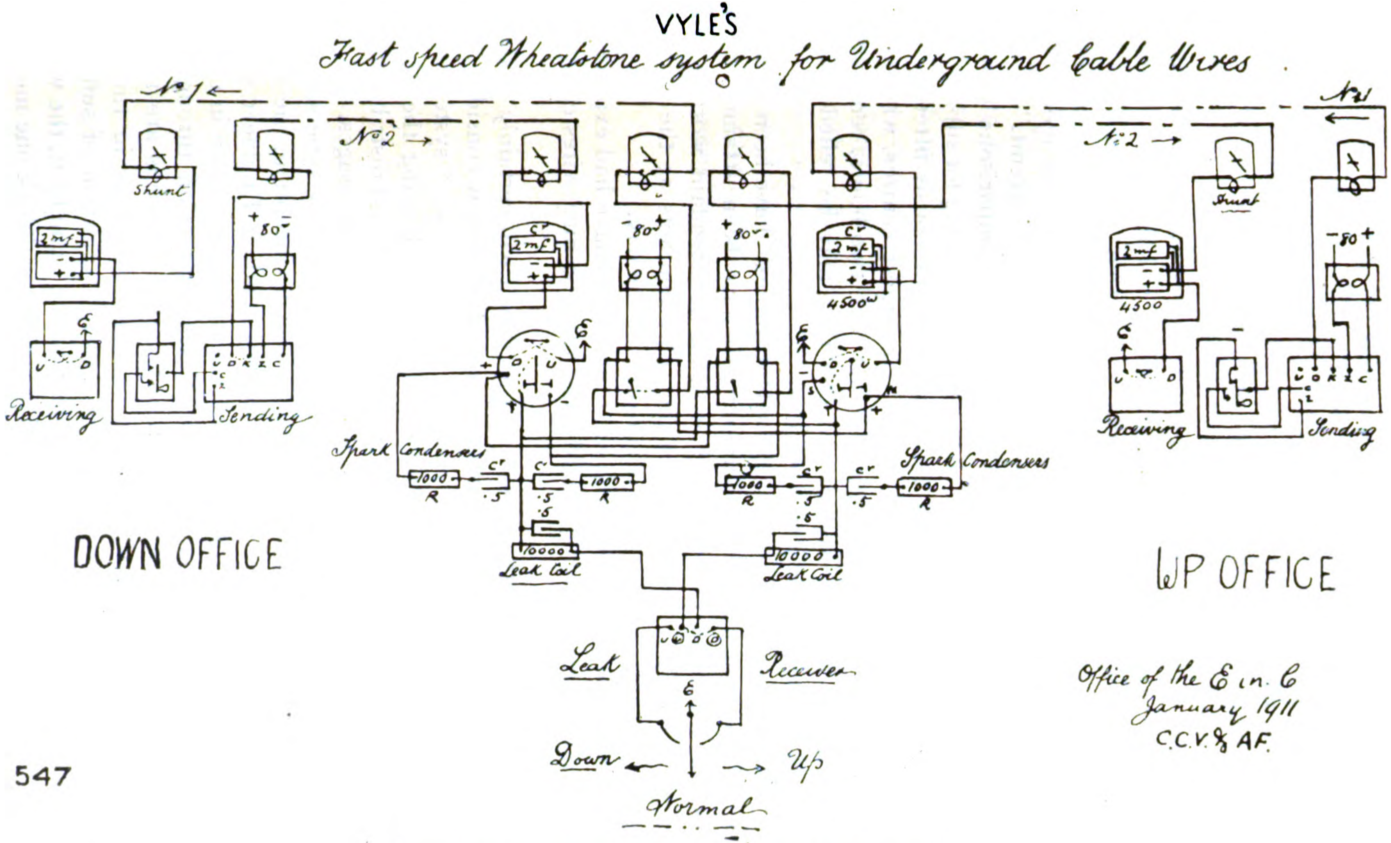
When the arrangements for the Glasgow–London circuit were completed an agreement was arrived at between the Controller of the C.T.O. and the Chief Superintendent at Glasgow for the circuit to be utilised entirely by London on one day from 10 a.m. to 4 p.m., and by Glasgow on the following day for the same period.

The results of the trials were as follows:

London to Glasgow	1742 messages.
Glasgow to London	1789 messages.

Tablet check sheets were kept at Glasgow for the purpose of recording the delay on the work, and a record was also kept of the number of repetitions required.

Of the total number of messages sent by London, 3·3 per cent.



2.—Connections of Simplified Form of Repeater.

repetitions (generally wrong numbers) was required, the percentage required by London on the following day being 2·4 per cent., while 79 per cent. of the messages dealt with at Glasgow were within the 10 minutes period.

On the whole the trial was a memorable one, and showed what can actually be done on our underground cables with the Wheatstone system of working.

Another trial between London and Glasgow was arranged for, in which the two offices worked up and down in batches of nine each way. What was the result? Simply this, that practically all the London–Glasgow channels were shut down and almost the entire volume of work between the two greatest cities in the Kingdom was carried by the pair of wires forming a single "Vylé circuit."

It is not the intention of the writer to draw comparisons between this system and the others which to-day are struggling for supremacy, but it is interesting to recall the remark spontaneously uttered by a shrewd and capable officer at one of our largest centres, who, after watching it in continuous operation for over two hours, remarked: "Yes, this is a stable system and one that may be relied upon." The implication is sufficiently obvious.

When the conditions for "equivalent duplex" have been secured the ideal of the harassed supervisor will have been attained. No more balancing in the mornings with all its attendant worries and delays. Simply a "rub up" of the relay contacts at the various repeating points and the circuit is ready for the day.

This is a great advance, and only those who have had experience in balancing and getting standard speed fixed on busy wires can fully appreciate its value.

So much then for the system as one which will certainly have to be reckoned with in the very near future. Let us now consider it in conjunction with what has come to be known as "systematic" Wheatstone working, in which the white slips bearing the Morse signals are gummed to the blue sheets of paper and distributed to the circuits in the same manner as ordinary "B" messages.

This "systematic" working, which will probably supersede the older manual method of writing up, owes its inception, the writer believes, to Mr. Wm. Noble, the Superintending Engineer of the Central Metropolitan District, who many years ago, when in charge of the Aberdeen section, put forward the suggestion through the local authorities. It may be contended that the slips are not so easy to read from in the process of transmission as in the case of the written-up forms; but this is surely a question of sufficient practice. As an actual example of what can be done by it, the writer, when in Birmingham recently, was informed at 9 o'clock one morning that during the previous hour 416 messages had been received and gummed up by one operator on the Milford Haven circuit. Is any further argument needed to justify its retention and extension?

The possibilities of the "Vyle" circuit (to give it the name by which it is known in the C.T.O. and provinces) must not be supposed, however, to be exhausted when the terminals are enabled to work to each other at 200 per minute. The TS–GW circuit could be utilised by TS to BM or PR or CE individually, or YQ, if the exigencies of the work required it; and its utility in this respect was amply demonstrated recently, when Carlisle used it as a channel to TS for a quantity of press work which, at the restricted time available, could not have been got rid of on the ordinary TS–CE channel.

And, lastly, it may be mentioned that an experimental circuit was made up between Sheffield and Aberdeen *viâ* London and Glasgow, comprising:

Sheffield to London . . .	160 miles	aërial,
London to Glasgow . . .	420 ,,	underground,
Glasgow to Aberdeen . .	160 ,,	aërial,

or altogether 740 miles in length. The simplex speed between SF and AB was 200 w.p.m., and the quality of the signals was such that had the trial been made between one end of the Kingdom and the other, with the entire stretch of underground thrown in between, a similar result would have been obtained.

PUTNEY TELEPHONE EXCHANGE TRANSFER TO NEW PREMISES.

By J. L. Taylor.

It is some years since the need for additional exchange equipment became an urgent matter at Putney. In consequence of various difficulties in connection with the acquisition of the site, it was not found possible to complete the new exchange building until this year. In the interval the cabling arrangements at the old exchange manhole had become little less than chaotic, due primarily to the fact that the main distributing frame facilities in the old test-room could not be extended, because of the lack of floor space; and secondly, to the impossibility of drawing up additional cables in the existing cable chutes between the manhole and the test-room. It was found necessary therefore to terminate a number of main cables in cable distribution heads in the manhole and to lead a limited number of pairs from each main cable up to the test-room. The cables that could not be fully utilised comprised three 1200/10 and two junction cables 24/100–400/20. The cables terminating on the main distributing frame in the old test-room included seven main junction cables, three subscribers' main cables, and nearly 100 14/20 cables, and as all of these were supported on a single cable-bearer in the limited space available in a 6 ft. by 4 ft. manhole, the task of evolving a workable scheme for extending the circuits to the new exchange was by no means a light one.

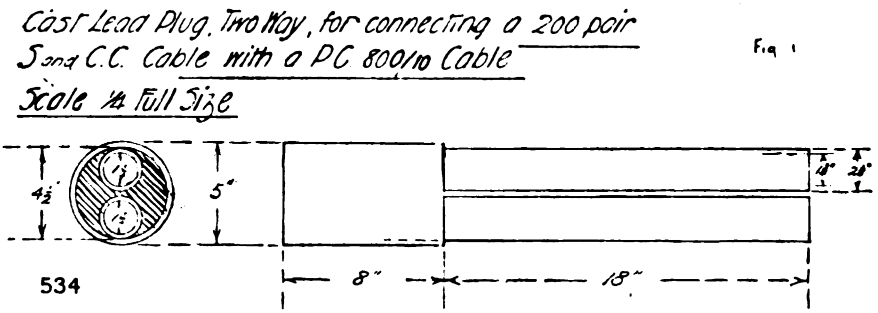
The manhole at the old exchange consists of two manholes connected by a brick tunnel. The original manhole is the 6 ft. by 4 ft. structure already referred to as containing the cable-bearer, whilst the second portion containing the main cables terminated in cable distribution heads is a 7 ft. by 5 ft. manhole. In view of all the circumstances it was agreed that the following scheme would best meet the requirements.

(1) Extend the three 1200/10 cables in the 7 ft. by 5 ft. portion of the manhole to the new exchange and divert the subscribers' circuits to these 1200/10 cables, which serve three different routes.

(2) Insert cable distribution heads on the subscribers' cables in the 6 ft. by 4 ft. portion of the manhole, in order that the working circuits might be extended to a teeing point.

(3) Provide an additional 800/10 subscribers' cable from a point near the junction for the new exchange in High Street, Putney.

(4) At the old exchange nearly 900 junction circuit pairs were terminated on the M.D.F., and in addition to these 600 junction pairs terminated in cable distribution heads in the manhole. These junction circuit cables comprise main junction cables from London, each of which is distributed to main and other junction cables to the Thames Valley exchanges. In view of the large number of through junction circuits it was decided that only two junction cables should be extended to the new exchange, to carry only the circuits required for Putney exchange. It was necessary, therefore, to insert cable distribution heads on the main junction cables led in at the old exchange and to provide a means of cross-connecting between the various cable distribution heads.


Cast Lead Plug. Two Way, for connecting a 200 pair
S and C.C. Cable with a PC 800/10 Cable
Scale ½ Full Size
Fig 1
4½"
5"
8"
18"
534

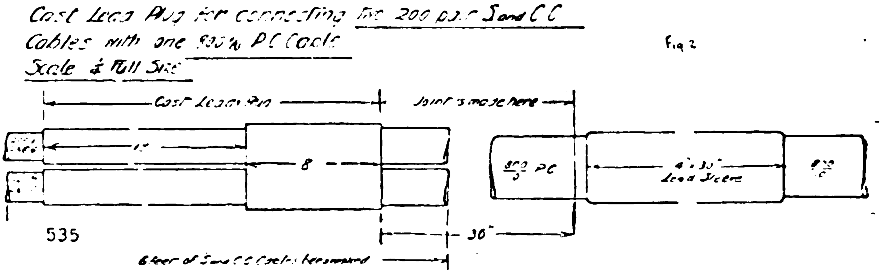
I.—Dimensions of Joint.

It is satisfactory to record that in spite of the difficulties due to the congested condition of the cabling arrangements and to the restricted space, the work of diverting the majority of the 1300 subscribers' circuits to the three 1200/10 cables, for extension to the new exchange, of cutting out nearly 1500 junction cable ends and of extending 200 junction pairs to the new exchange was done with a minimum of interference to the existing circuits, notwithstanding the fact that a large amount of diversion work in connection with the Putney cabling development scheme had to be dealt with in the same manhole at the same time.

After the completion of the diversions to the cables that were extended to the new exchange, it will be understood that the actual operation of teeing the circuits was a simple one, the tee in every case being made in a cable distribution head.

In the arrangements for transferring the working circuits to the new exchange the use of a change-over frame was dispensed with, as there was no accommodation for the apparatus or cables at the old exchange. Each circuit was therefore extended direct to the new exchange. On the M.D.F. at the new exchange the glass tube fuses were not inserted in the fuse mountings of the subscribers' cables until the whole of the work, both inside and outside, had been completed and tested, and the circuits had been insulated at the line and cut-off relays. The junction circuits were insulated at the heat-coil strips until brought into use.

Experimental trials of the usual method of insulating the subscribers' circuits at the line and cut-off relays by inserting a microscope glass between the contacts of each relay showed that at least 50 per cent. of the glasses failed to drop when a peg was inserted in the corresponding jack, and that any alteration made to the springs of the relay in order to permit of the glass dropping gave rise to disconnections, which at the change over would have caused considerable trouble. This difficulty is due to a slight difference in the construction of the relay contacts as compared with the older form of this type of line and cut-off relay. As the time occupied in getting the whole of these relays into proper adjustment for the circuit arrangements had extended over a number of weeks, it was considered necessary to find a method of temporarily insulating the circuits which would avoid any interference with the contacts, and which would enable the circuits to be joined up to the new exchange without undue loss of time. The method adopted was the insertion of a small wedge-shaped piece of wood between the armature and the body of the coil of each line and cut-off relay, thus operating the contacts without touching them. Through a small hole at the free end of each wedge was slipped a length of twine for each strip of ten relays. On the receipt of the change-over signal the wedges were pulled out, after which the operators commenced the tests for "no


Cast Lead Plug for connecting the 200 pair S and C C
Cables with one P C Cable
Scale ¼ Full Size
Fig 2
Cast Lead Plug
Joint is made here
12
8
P C
Lead Sleeve
535
30"

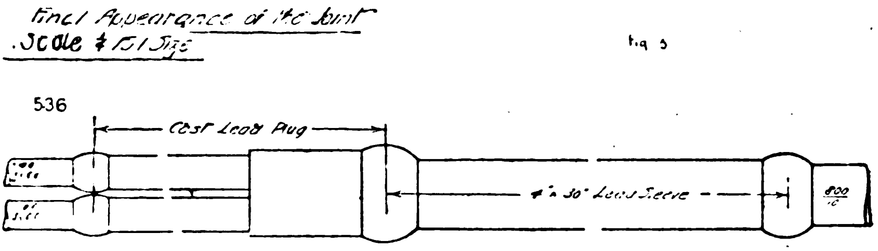
2.—DIMENSIONS OF JOINT.

glows." It will be seen this method obviates the need for the preliminary pegging in at every jack by the operators in order to energise the cut-off relays.

With regard to the junction circuits the usual practice was adopted of transferring about half the working lines shortly before the change-over, which was arranged to take place at a time when half the junctions would be sufficient to carry the traffic. All the working junction circuits were teed through to the new exchange precisely in the same way as the subscribers' circuits, and were left disconnected at the heat-coil strips until brought into use. In every case preliminary tests were made with the exchanges concerned.

Prior to the change-over the following alterations were made:

Subscribers' Circuits.—(1) The receivers were tested in order to ascertain whether the polarity assisted the 24-volts common battery, and, where necessary, the connections on the receiver were reversed. The nature of the tests made is indicated in diagram 3 on page 206, vol. i, of this Journal.



3.—Completed Joint.

(2) Exchange circuits with one extension having intercommunication (diagram C.B.S. 5).

In order to prevent a permanent ring on the trembler bell when the extension is put through to the C.B. exchange the connections of the local bell circuit were modified, as shown in Diag. 1, page 205, vol. i, of this Journal.

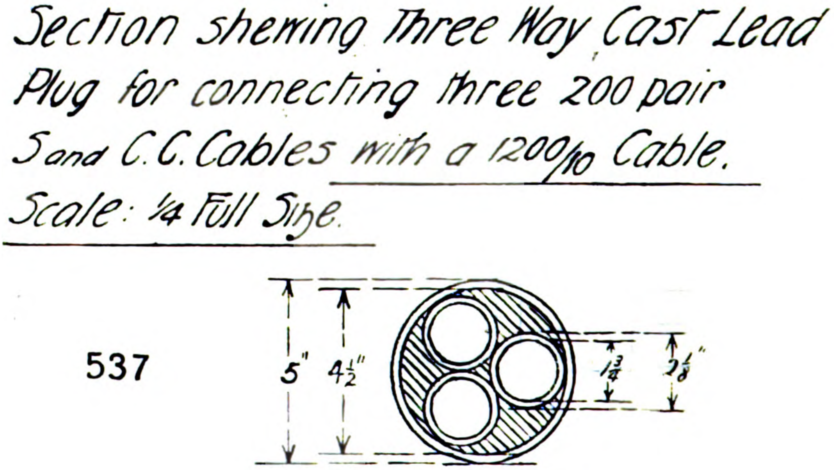
(3) Heat coils B. ($28{\cdot}5^{\omega}$ to $31{\cdot}5^{\omega}$) at subscribers' premises were replaced with heat coils A. green ($4{\cdot}5^{\omega}$ to $5{\cdot}8^{\omega}$) in order to give a higher striking point, and also to reduce the resistance of the circuits to the lowest possible figure.

(4) Where C.B.S. switchboards were installed a spare jack was short-circuited in order to provide a means of holding the exchange while the attention of an extension was being obtained.

Alterations at the New Exchange.—As there is neither a four-volt tap on the twenty-four-volt battery nor party-line ringing at the new exchange, the only alteration necessary, in order to permit of the C.B. exchange working to C.B.S. stations, is in the ringing circuit of the "B" boards. The object of the alteration is to prevent the tripping relays being actuated by the earth on the A line at the subscribers' instrument. The tripping relays were therefore removed from the generator lead and placed in the ringing return. 5 shows the alterations made.

ALTERATIONS AT THE OLD EXCHANGE.—The earth "commons" were disconnected from the Ericsson main distributing frames in order to avoid putting earth on the "teed" lines when the heat coils were withdrawn at the time of the change-over.

The method of leading in the cables from the cable-chamber and terminating them on the M.D.F. is, perhaps, deserving of mention. A typical case is that of a 1200/10 P.C. cable. The M.D.F. is of the vertical type, *i.e.* the cables are laced out vertically on both sides of the frame. Each vertical accommodates 200 pairs. Hence for a 1200/10 cable it is necessary to lace out the pairs on three verticals. In practice the P.C. cable terminates in the cable-chamber, and is extended to the M.D.F. by means of three 200-pair S. and C.C. cables. One three-inch pipe per vertical connects the floor of the test-room and the ceiling of the cable-chamber, and one cable per vertical is drawn up through each pipe. As these cables require to be laced out from the bottom to the top of the verticals it is necessary to "re-form" each cable, so that the first twenty centre pairs may be laced out on the bottom fuse mounting, there being ten such groups per vertical.


Section shewing Three Way Cast Lead Plug for connecting three 200 pair S and C.C. Cables with a 1200/10 Cable.
Scale: 1/4 Full Size.
537
5"
4½"
1¾
2⅛"

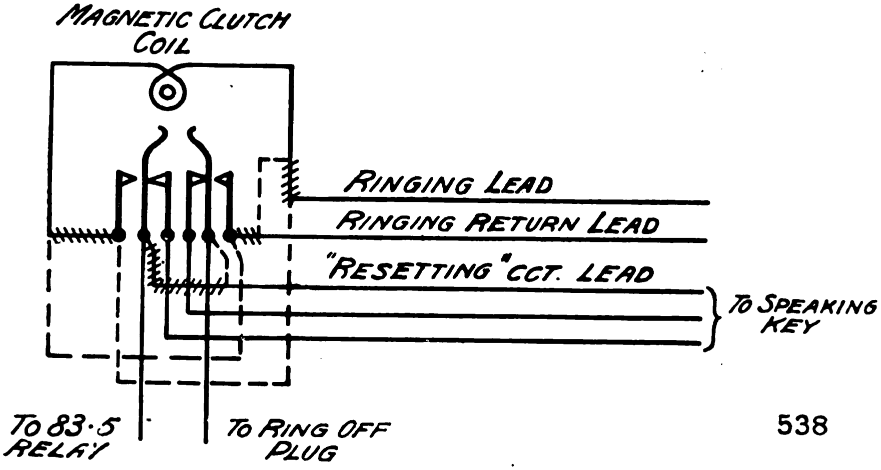
4.—SECTION OF THREE WAY PLUG.

The reasons that led to the adoption of a modification of the usual joint between the S. and C.C. and P.C. cables at Putney were as follows:

(1) The isolated position of the new exchange building rendered it essential that in the event of a fire occurring, the cables could, if

required, be extended to the ground at the rear of the exchange. A numbered-through joint on each cable was, therefore, necessary in the cable-chamber. It may be stated here that a numbered-through joint on each cable was also made at the junction for the new exchange in High Street, Putney.

(2) Experiments made with beeswaxing S. and C.C. cables by means of the apparatus ordinarily used for compounding-solid joints, show that if the process of beeswaxing these cables is done before the lead covering is stripped off, *i. e.* before the S. and C.C. insulation is exposed to the atmosphere, the loss of insulation usually associated with this type of cable is prevented. For these reasons the S. and C.C. cables were treated with beeswax, which had been heated by means of a compound melting-pot, and which was forced into the cable under a pressure obtained from a motor desiccator. At one end of the cable a length of about 18 ft. requires to be treated for lacing out on the M.D.F., and at the other end about 6 ft. for the joint between the P.C. and the S. and C.C. Upon the end of the cable under treatment is "wiped" an air nozzle, and at the extremity of the length required (either 18 or 6 ft. distant) an outlet hole is made in the sheath of the cable. The boiling wax is forced into the air-nozzle until it travels through to the outlet hole. Insulation tests made after the cables had been so treated and laced out indicate that it is possible to obtain readings of from 500 to 1000 megohms.

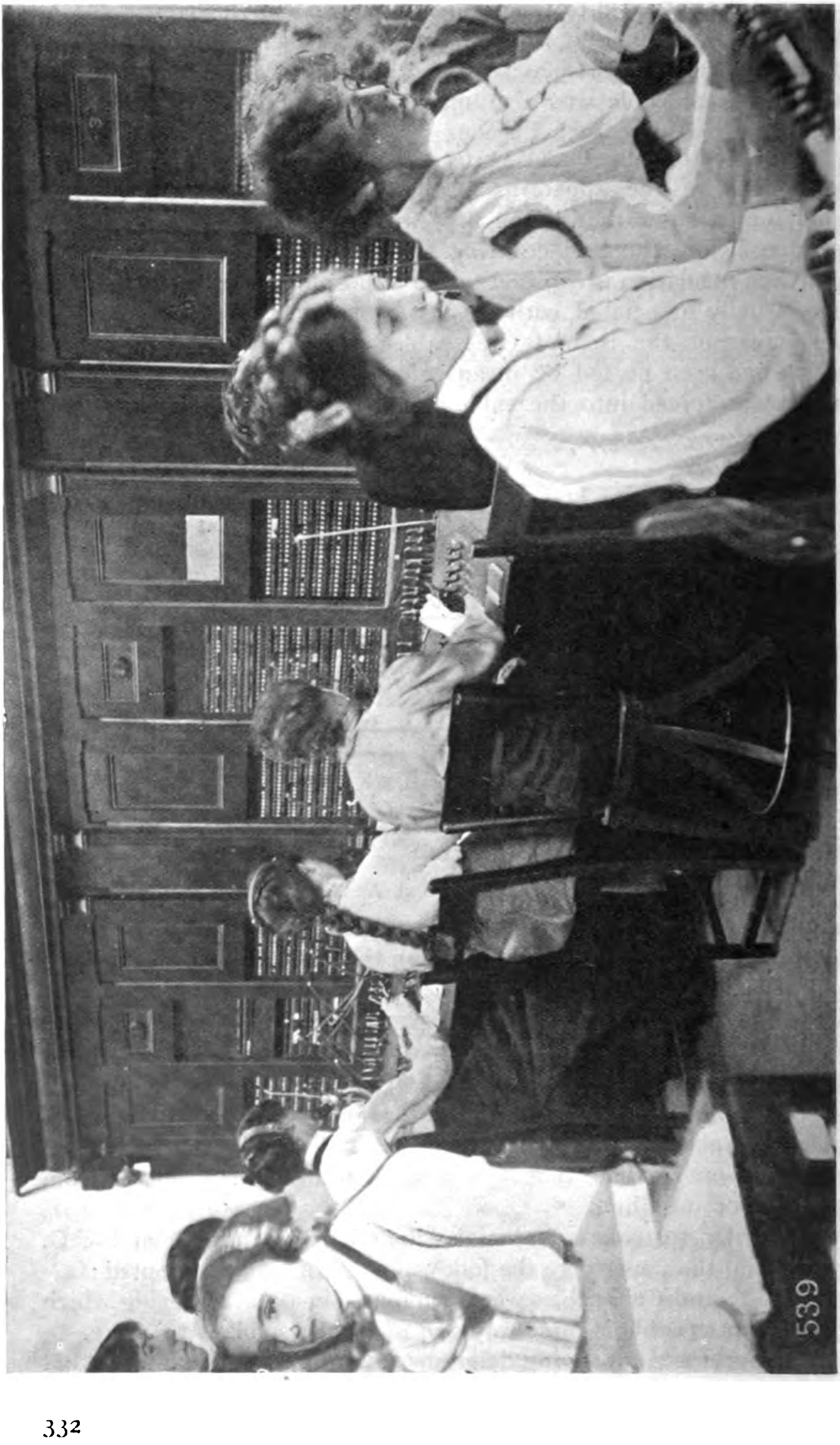


5.—Alteration to Ringing Arrangements.

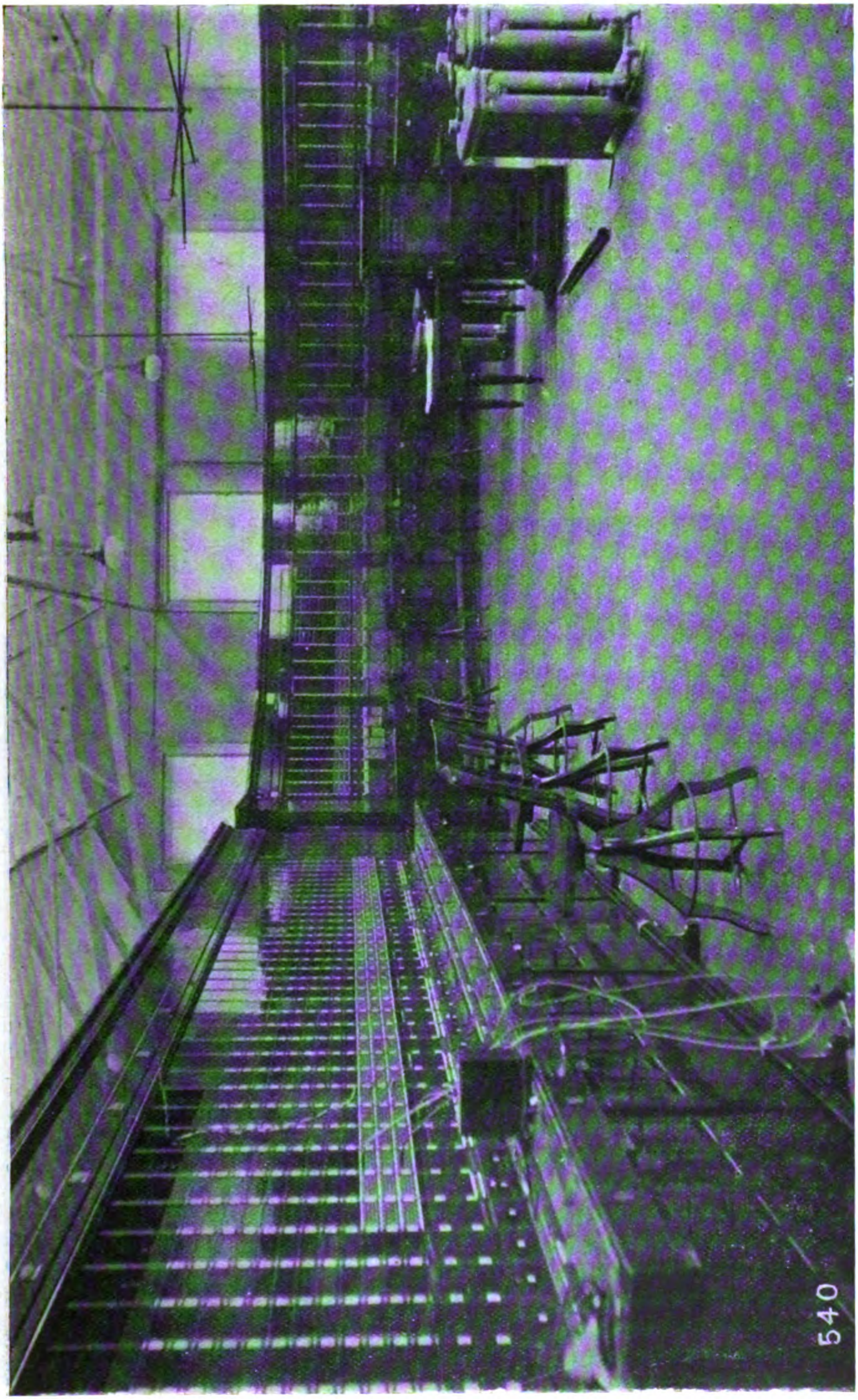
In order to make an air-tight joint between the S. and C.C. cables and the paper core the following expedient was adopted:

The S. and C.C. cables were terminated in a cast lead plug which for a 1200/10 cable is three-way and for 800/10 cable is two-way.

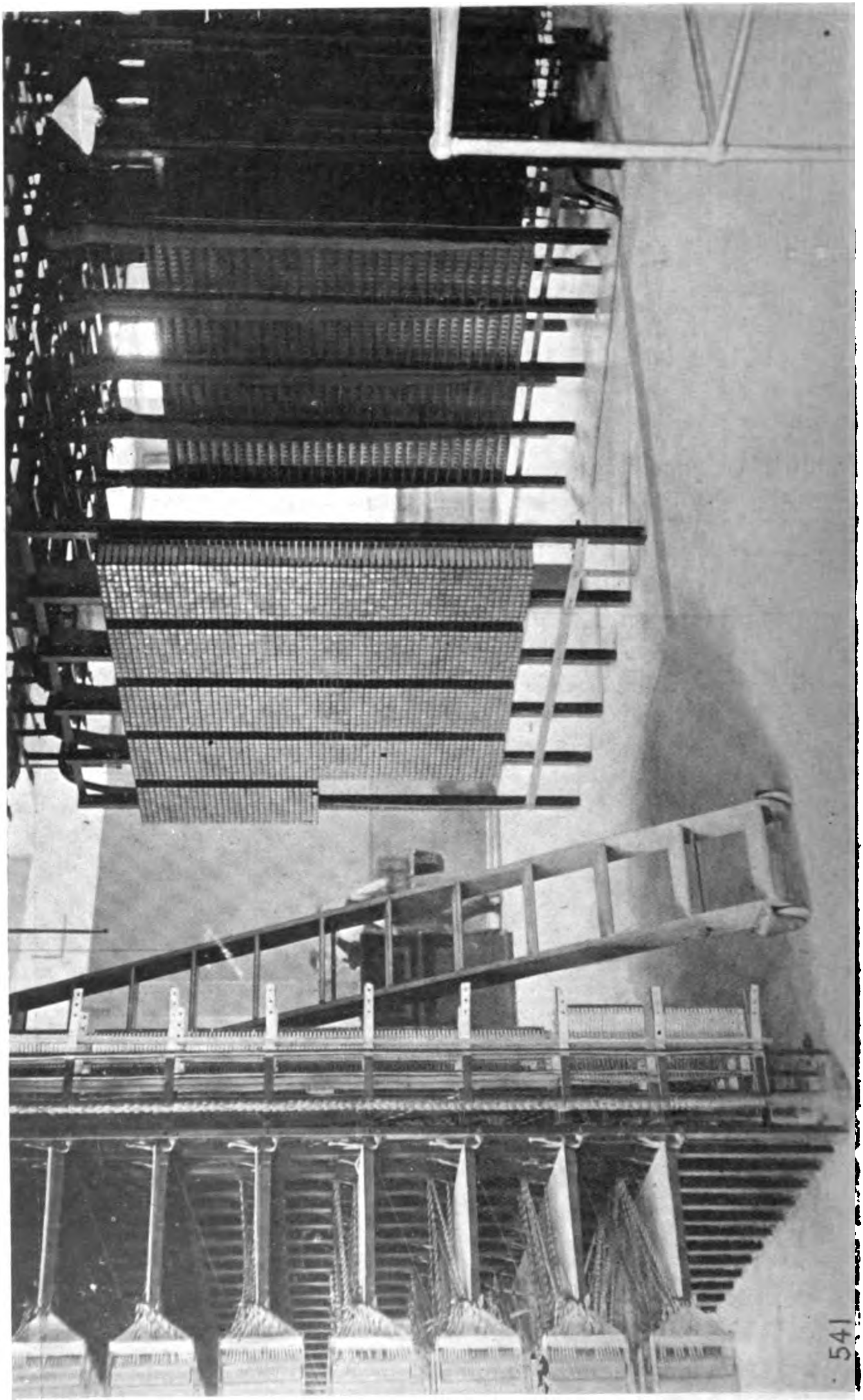
From the accompanying diagrams **1**, **2**, **3** and **4**, it will be seen that



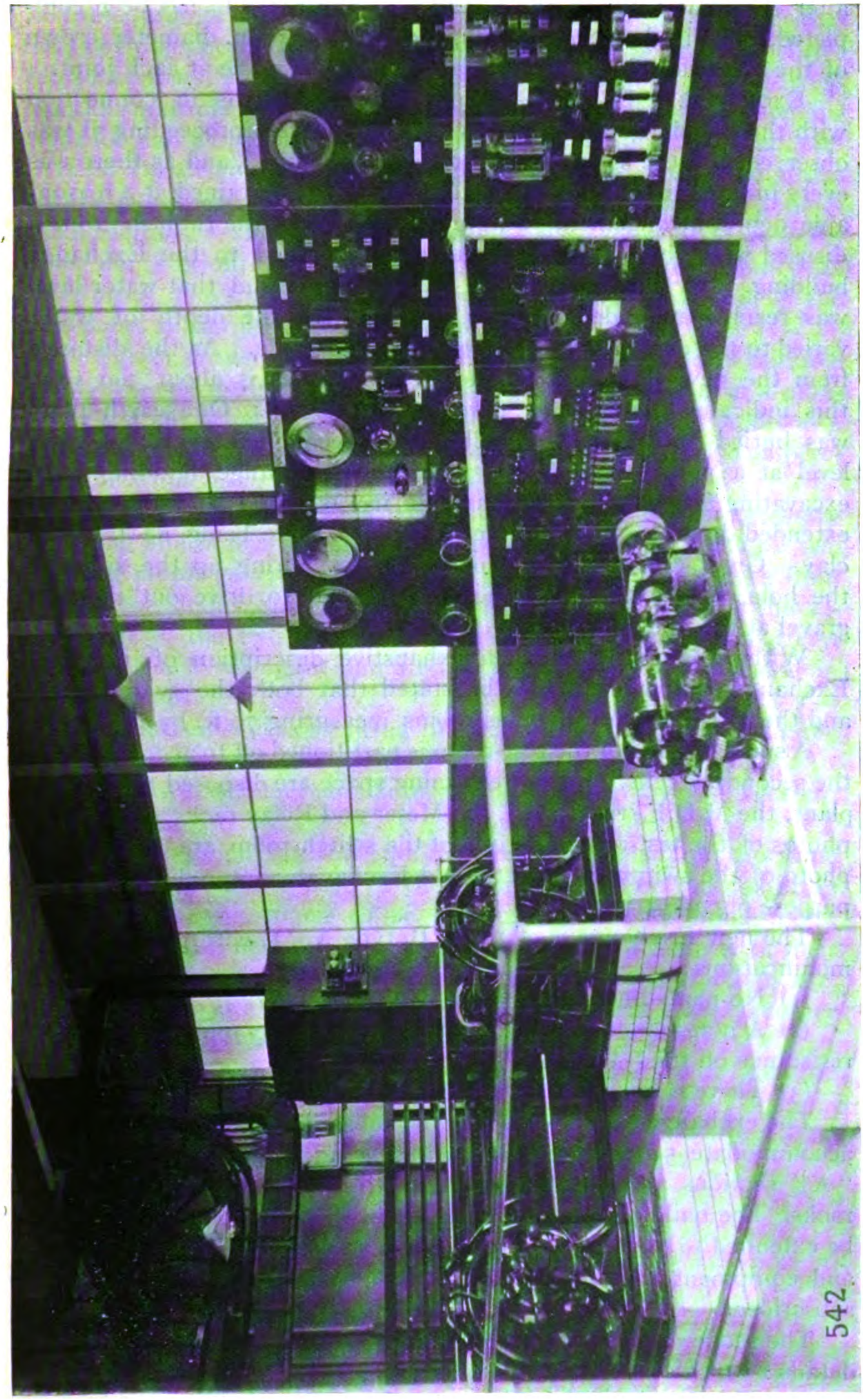
6.—Switch-room, Putney Old Exchange.



7.— Switch-room, Putney New Exchange.



8.—Test-room, Putney New Exchange.



9.—Power Board, Putney New Exchange.

after the joint between the S. and C.C. and the P.C. has been completed, the 4 in. lead sleeve is slipped into the 4½ in. diameter crown of the cast-lead plug, and plumber's " wipes " made at each joint.

EXCHANGE " EARTH."—While the excavations in connection with the foundations of the new Exchange were proceeding it was observed that the soil consisted of very fine gravel, and as there was every indication that a good earth could not be obtained at a reasonable depth, arrangements were made to dig out the rubbish from a disused well which existed in the yard attached to the Exchange building. On clearing out the well it was found that water level was reached at a depth of 20 ft., and that the depth of water varied to the extent of three feet with every tide. As the distance from the new Exchange to the River Thames is about 300 yds., this indicates the extreme porosity of the soil. One earth plate was buried in the disused well, and a second plate at the water level at a point about 15 ft. from the Exchange building. In excavating for the second earth plate it was found that fine gravel extended down to the water level (20 ft.), there being no trace of clay. Great difficulty was experienced in shoring up the sides of the hole, as the action of the tides tended to drive out the fine gravel at the bottom.

Without entering into an exhaustive description of the new Exchange equipment, it may be stated that both the switch-room and the test-room are spacious rooms measuring 70 ft. by 40 ft.

A small portion of the test-room is partitioned off to accommodate the secondary cells. In the remaining space are disposed the power, plant, the M.D.F., the I.D.F., the Meter and Relay racks, etc. Two photos of the test-room and one of the switch-room are shown. A photo of the switch-room at the old Exchange is reproduced for the purpose of comparison.

The new Exchange is of the C.B. type No. 1, with the following modifications:

(1) No party-line ringing is provided.

(2) A non-inductive resistance on the line relay replaces the lamp resistance on the " B " line.

(3) There is no 4-volt tap on the 24-volt battery.

The exchange is equipped for 2700 subscribers. The building can accommodate 5400 subscribers with the addition of the necessary " A " sections and the extension of the multiples and apparatus racks. The building has been designed so that the switch-room may be extended to double its present length, and the multiple, cable runs and equipment can accommodate an ultimate capacity of 10,800 subscribers.

The scope of the installation may be gauged from the following details:

SUBSCRIBERS' SECTIONS.—Six eight-panel sections, three operators' positions per section, maximum load per operator per position 180 subscribers, 2700 nine-panel subscribers' multiple, 240 six-panel junction multiple, one operator's test position, and the usual equipment for call wires, busyback, cord testing, operators' speaking, etc.

JUNCTION SECTIONS.—The incoming junction boards comprise 1 three-panel section for the electrophone distribution and 4 nine-panel sections. The nine-panel sections have three operators' positions per section, and each position accommodates twenty-six junctions. The six-panel outgoing junction multiple as well as the nine-panel subscribers' multiple is available.

ACCUMULATORS.—Two sets of eleven cells in lead boxes suitable for an ultimate maximum discharge of 1200 ampère-hours at a nine-hour rate, but fitted at present with plates for 600 ampère-hours at a nine-hour rate, and one 30-volt meter battery of 15 cells for 60 ampère-hours at a nine-hour rate.

POWER.—The four-panel power-board provides the necessary switching and indicating arrangements in connection with the two charging motor-generators, one ringing motor-generator driven from the 205-volt mains, one ringing motor-generator driven from the 24-volt battery, the two 24-volt batteries, the 30-volt meter battery, etc. Both a Watt-meter and a recording ammeter are included in the equipment.

A supervisor's desk is fitted in the switch-room, whilst in the test-room there is a two-position wire chief's desk.

The plant has been manufactured and installed by the Western Electric Company.

Accommodation for the staff has been provided on the same ample lines as in the case of the equipment. For the operating staff there are large rooms to be used as cloak-room, dining-room, and rest-room. The kitchen and appurtenances are the best of their kind. The same remarks apply to the linemen's room, kitchen, etc. One large room is allocated to the inspector's class, whilst another is used by the exchange manager.

An engineer's section stock is accommodated in a suitably designed stores-room in the basement.

The whole building is lighted by electricity and heated by means of a hot-water system of pipes and radiators.

AN AUTOMATIC COUNTER FOR SUBSCRIBERS' EFFECTIVE CALLS.

By P. V. CHRISTENSEN.
Engineer of the Copenhagen Telephone Co.

THE simplest way of counting connections is by counting the number of calls made by each subscriber. This may be done automatically by connecting the subscriber's signal or lamp to an electro-magnetic counter, which shifts a figure every time the subscriber's signal drops or his lamp glows.

The number shown by the counter will include: (a) effective calls; (b) ineffective calls; (c) false signals.

Part of the "c" counts may be eliminated by connecting the counter to the subscriber's answering jack instead of to the signal or lamp; the counter will then shift a figure every time an answering plug is put into the subscriber's answering jack.

In order to eliminate the remaining "b" and "c" counts an additional arrangement is introduced. The counter is connected to the answering jack as above said, but, besides inserting the answering plug, a second condition must, however, be fulfilled before the counter shifts a figure. In certain C B exchanges this second condition is fulfilled when the called subscriber takes off the receiver. It would seem that in this way the highest perfection of an automatic counter had been reached. Special arrangements for each pair of cords are, however, required, and it is difficult to arrange such counters in C B exchanges already working, and it cannot be done in magneto exchanges.

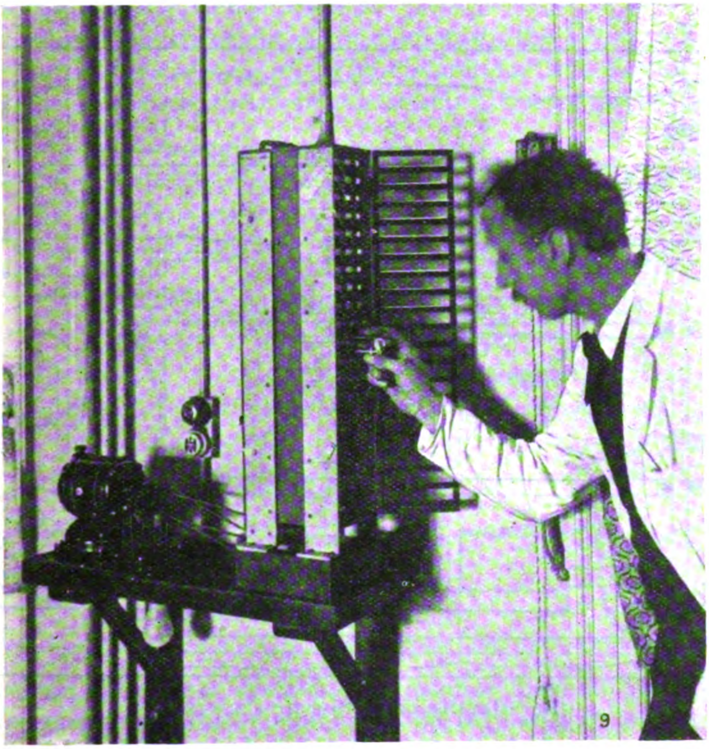
In Copenhagen it was desired to arrange a fully automatic counter in the C B and magneto exchanges already working.

As second condition the time "T," in which the answering plug remains in the answering jack, was taken into consideration.

In the case of "a" counts mentioned above, "T" is considerably greater than in the cases of "b" and "c" counts. The counter is constructed so that it separates the greater values of "T" from the smaller values of "T." The limit is made 30 sec., as "a" is deemed to correspond to "T" > 30 sec., and "b" and "c" to "T" < 30 sec.

The automatic counter described here is constructed so that it only registers the calls for which the time is "T" > 30 sec. The counter is worked by an electric motor, and it must be noted that an alteration of "T," for instance of between 15 and 45 sec. does not require a differently constructed counter, but only an alteration in the transmitting gearing between counter and motor.

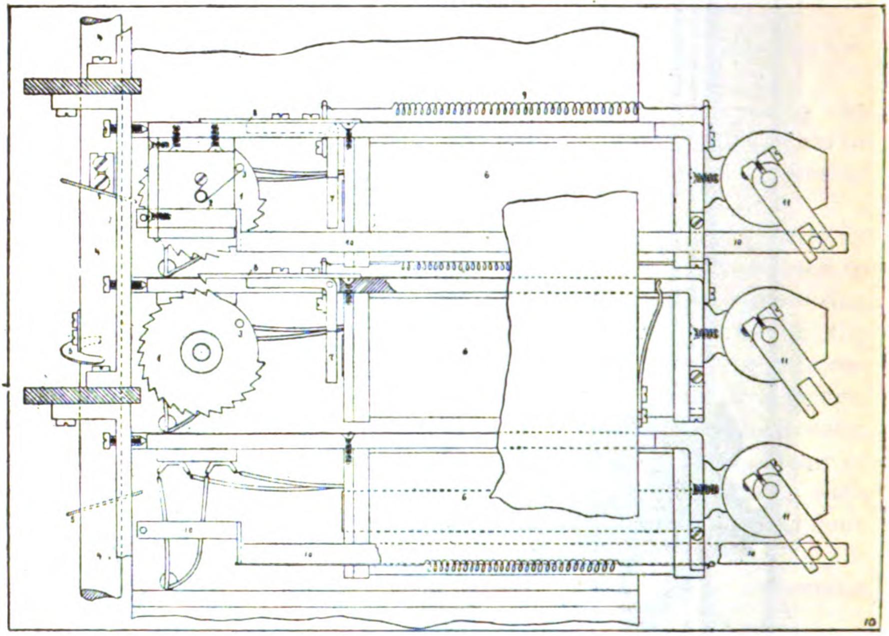
1 shows a cabinet containing sixty counters and the electric motor, which may be used in joint connection with a larger number of cabinets. The dimensions of the cabinet are 175 × 138 × 663 mm., so that in the case of larger constructions 650 counters may be had per square metre. Each counter may be removed by loosening a screw. On the glass door the subscriber's telephone numbers are fixed in the framework. The counters are arranged in three vertical columns, with twenty in each column. Behind each column is a vertical shaft which is kept permanently rotating by the electric motor.



1.—Cabinet with Sixty Automatic Counters.

2 shows the details of construction. *11* is a "Veeder counter," the lever of which is worked by the rod (*10*). An electro-magnet (*6*) carries the armature (*7*). The armature is drawn away from the magnet by means of the spring (*9*). The armature carries a pawl (*8*). When the electro-magnet attracts the armature the pawl (*8*) engages a ratchet-wheel (*1*). This ratchet-wheel is carried by two pivots, and is held at rest by the spring (*2*). At the left is seen the rotating shaft (*4*), on which is fixed a slanting blade (*5*) (screw sector) for each counter. The blade (*5*) engages a ratchet of the wheel (*1*) and moves it upward during the one-half revolution of the shaft (*4*), during the other half revolution of the shaft the ratchet-wheel is disengaged by the blade, and is brought back to its former position by the spring (*2*).

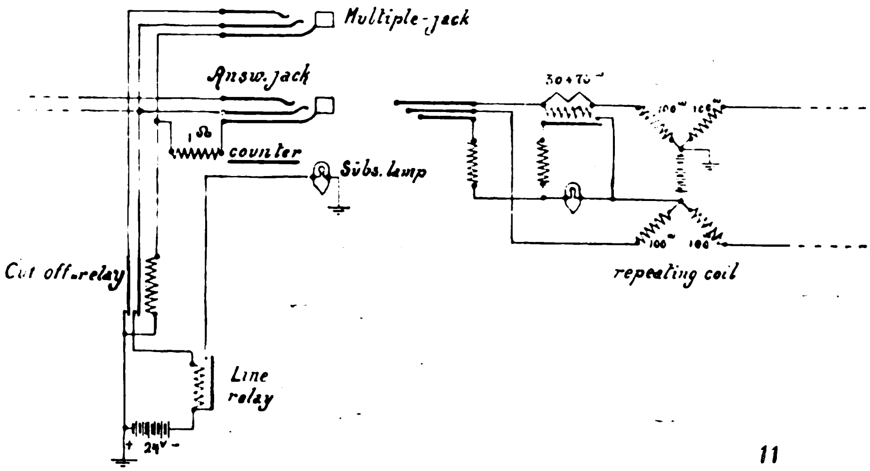
When no current passes through the electro-magnet (*6*) the ratchet-wheel will permanently have a forward and backward motion with thirty oscillations per minute. The electro-magnet (*6*) is connected to the subscriber's answering jack in such a way that current continually passes through it when there is a plug in the jack. The moment the answering plug is inserted the electro-magnet will attract its armature, and the pawl (*8*) will engage the ratchet-wheel. The oscillating motion of the ratchet-wheel will now become a progressive motion, as the backward, but not the forward, motion of the ratchet-wheel is retarded by the pawl. After some time the ratchet-wheel will have turned so far that the tap (*3*) engages the knee of the rod (*10*). During the further motion of the ratchet-wheel the rod (*10*) will travel in a horizontal direction, and will move the lever (*11*) of the counter.



2.—Details of Automatic Counters.

When the ratchet-wheel has turned yet more the last ratchet of the wheel will have passed the blade (*5*), and the wheel will then remain in this position whilst the lever of the counter will be drawn completely back. When the plug is withdrawn from the jack the electro-magnet (*6*) is demagnetised, the spring (*9*) removes the pawl (*8*) from off the ratchet-wheel and the wheel is turned back by the spring (*2*), while another spring (shown only on the lower counter) moves the rod (*10*) and the counter lever forward again. By this operation the counter shifts a figure. If the plug was withdrawn from the jack at an earlier stage ("T" < 30 sec.) the counter lever (*11*) would not be drawn completely back, and would consequently not move the figures of the counter.

3 shows the arrangement of the counter for the Western Electric Co.'s central battery system. The counter for this system has a resistance of 1 ohm, therefore consuming about 25 milliwatts. In connection with other systems, for instance magneto-systems, it is of importance that this counter can be regulated to a very small consumption of current down to 10 milliwatts.

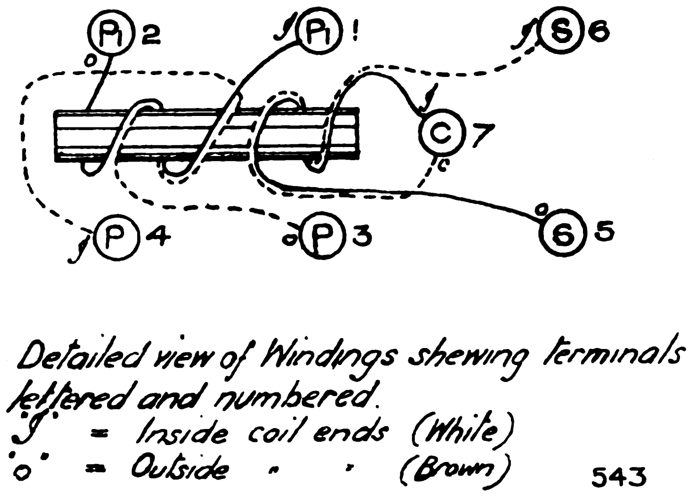


3.—Western Electric Co.'s C.B. Subscriber's Line with Automatic Counter.

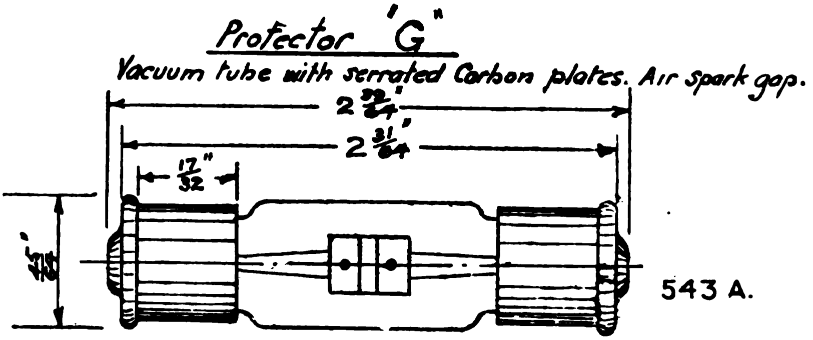
NEW IDEAS.

Protection of Transformers in Pole Test-boxes.

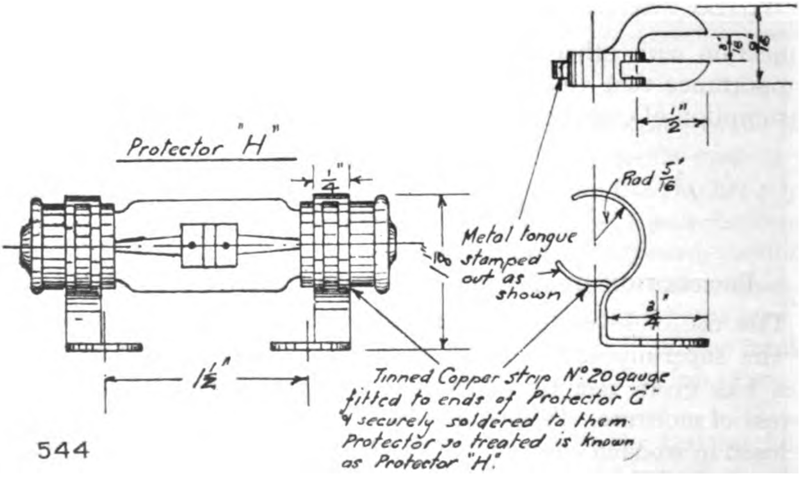
The use of seven-terminal transformers fitted in pole test-boxes for the superimposed working of telegraph channels on telephone lines has given rise to much maintenance trouble owing to the ingress of moisture. To obviate this trouble transformers completely enclosed in wooden cases 6½ in. by 3½ in. by 3 in. have been brought into use with a large measure of success. The coils are baked and


P1 2
o
J P1 1
J S 6
J
C 7
c
o
S 5
J P 4
o P 3
Detailed view of Windings shewing terminals lettered and numbered.
"J" = Inside coil ends (White)
"o" = Outside " " (Brown)
543

I.—Connections of 7-Terminal Transformer.

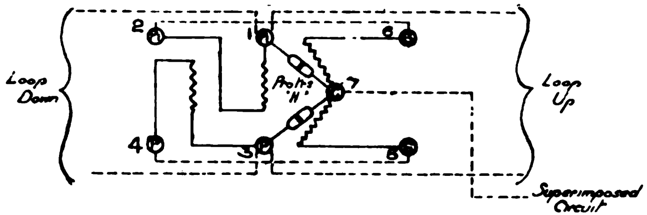


2.—Vacuum Protector.


3/16"
9/16"
1/2"
Rad 5/16"
Protector "H"
1/4"
Metal tongue stamped out as shown
3/4"
1 1/2"
Tinned Copper strip No 20 gauge fitted to ends of Protector "G" & securely soldered to them. Protector so treated is known as Protector "H".
544

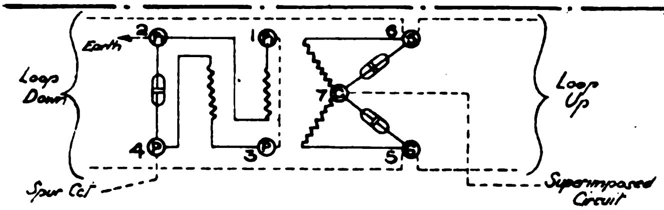
3.—Protector Clips.

treated with paraffin wax *in vacuo* before they are fitted in the case, and the remainder of the space is then filled with wax, thus forming a solid mass well calculated to resist the entry of moisture. Apart from the trouble due to moisture there was reason to fear that a considerable number of faults were due to lightning discharges, and to render the transformer still more efficient it has recently been decided to make provision for fitting them with lightning protectors.



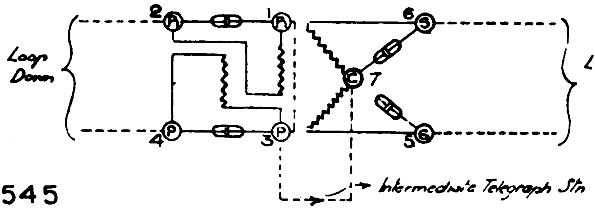
4

Superimposed single wire Circuit connected to metallic loop at Intermediate point Transformer used as Bridging Coil 2 Protectors 'H' fitted to protect Coils from lightning



5

Superimposed Circuit and Transformer spur Circuit on metallic loop 3 Protectors "H" fitted to protect coils from lightning In the absence of a Superimposed circuit at this point the two protectors on terminals 5 6 & 7 would be replaced by a single protector joined between terminals 5 & 6

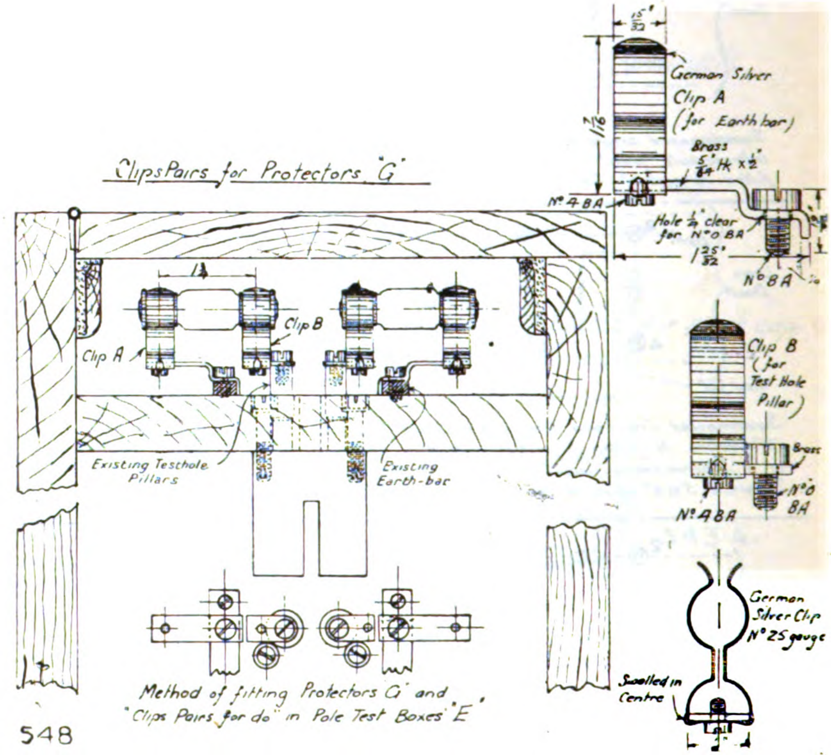


545

Intermediate station on superimposed telegraph circuit served from intermediate point on divided loop 4 Protectors "H" fitted The same arrangement would hold good for two independent superimposed circuits connected respectively to the up and down sides of the loop

In the latest design of instrument the terminals are mounted on the top of the transformer on an ebonite slab $\frac{3}{8}$ in. thick, and to facilitate the fitting of the protectors the position of the terminals has been rearranged as shown in 1.

In view of the fact that these transformers are used largely in damp situations it was necessary to provide for a type of protector not susceptible to loss of insulation in the presence of moisture, and as the result of a series of tests it was decided to adopt the vacuum protector shown in **2** as being the most suitable for the purpose. By comparison it has been shown to be more sensitive than either the old "vacuum protector" used by the Post Office, the circular carbon protector "C," or the small rectangular type "D." The new protector consists of a vacuum tube containing two serrated carbon electrodes with spark-gap, and will be known as protector "G."


15/32"
German Silver Clip A (for Earth bar)
1 7/16"
Brass 5/64" Hk x 1/2"
No 4 BA
Hole 1/8" clear for No 0 BA
1 25/32"
No 8 BA
Clips Pairs for Protectors "G"
1 1/2
Clip B
Clip A
Clip B (for Test Hole Pillar)
Brass
No 0 BA
No 4 BA
German Silver Clip No 25 gauge
Swelled in Centre
Existing Testhole Pillars
Existing Earth-bar
Method of fitting Protectors "G" and "Clips Pairs for do" in Pole Test Boxes "E"
548

7.—Method of Fitting Protectors.

These protectors have been provided with special extension clips to permit their ready connection direct to the transformer terminals. This combination of protectors G and extension clips will be known as protector "H." The clips consist of stamped copper strips, and they are securely soldered to the ends of the protector as shown in **3**.

The encased transformer now being introduced will fit in the later form of small pole test-boxes known as "F," but cannot be accommodated in the older pattern, which was originally designed for a small plug switch; it will therefore be necessary in some cases to change the test-box.

It will prevent risk of breakage if the protectors are fitted to the transformer after the latter has been placed in position in the test-box.

4, **5**, and **6** show diagrammatically the measure of protection afforded in a few typical cases by means of protectors " H " fitted to seven-terminal transformers.

It is also intended that this new type of vacuum protector shall supersede the carbon plate protector with a mica separator now fitted in the pole test-boxes " E " in positions where satisfactory insulation is difficult to maintain. " Clips pairs for protectors G " shown in **7** enable the change to be made with a minimum amount of disturbance to the existing fittings in these boxes. **7** also shows the method of fitting protectors G and " clips pairs for protectors G " in pole test-boxes E.

CABLE FAULTS AND THEIR REMOVAL: AN EXPERIMENT.

THESE are days of pressure, and there are few engineers who are not more or less affected by the bustle and rush of modern methods. Yet it is certain that much time and energy are wasted because it is found impracticable to pause and consider what are the best means of dealing with emergency works. These often present very complex problems, for the solution of which more time for reflection and review is required than the Post Office engineer is able to bestow. For example, when a cable breakdown occurs owing to saturation with water, should the cable be dried out by heat and air, or should the damaged section be renewed ?

Most engineers have had experience of paper cables damaged by water, and, perhaps, after the application of the desiccator for a time, the cable was sufficiently restored to carry the working circuits, but its insulation resistance was never so high after, as it was previous to, the breakdown. In such circumstances the first and only consideration is, "get the circuits through." There is neither time nor opportunity for careful investigation, consequently phenomena frequently pass unobserved, and therefore unexplained. There is, however, a reason for the low insulation resistance, and because of its importance in the future good working of the cable it is worthy of careful inquiry. Hence, with a view towards the solution of this problem, the result of a recent experiment is submitted for consideration.

A gallon of water from the Regent's Canal was placed in an ordinary galvanised iron pail with a short length of 14/10 paper core cable, the lead sheathing of which was slightly damaged, so that water could find its way into the core. The wires were bared and bunched at one end and connected to the positive pole of a dry-cell battery of about 24 volts, while the lead sheathing was attached to the negative plate.

This arrangement was continued for twelve hours, but the cable was immersed for thirty hours. On the removal of the cable from the water the lead sheathing was stripped, when it was observed that the water had travelled only a few inches along the paper on either side of the opening in the sheath.

The insulating paper was badly stained with a dark greenish substance which proved to be copper. This discoloration was quite noticeable and easily detected by the naked eye. After the cable had been thoroughly dried by the application of heat, tests were made for the presence of copper in the insulating paper. It was found that even on a small piece of the outside wrapping an appreciable amount of copper was present. There were also traces of lead, but it is thought that the presence of lead was due to mechanical contact.

At first sight the factors of the experiment, viz. saturation in more or less dirty water for thirty hours with a current from a battery of about 24 volts applied for twelve hours, may seem too severe. It may be well, therefore, to remember the following points met with in actual practice:

(1) The damaged cable might consist of 1200 wires, any number of which may be earthing in consequence of the wet section, and many of its wires may be connected at an exchange to an earthed battery of 24 or higher voltage.

(2) The water from the canal in question more nearly resembles water after passing through the average city soil than water from any other source.

(3) Twelve hours is not too long to allow for the thorough restoration of a wet cable.

With these factors in view it is not unreasonable to suppose that electrolysis to a considerable extent would take place. The difficulty, however, is to decide without delay on the course to be adopted in effecting repairs. That is to say, should the cable be replaced or should it be dried out. Of course each case of damage must be considered on its merits; but still a rule for general guidance might be suggested as follows:

Immediately the underground chamber has been cleared of water remove a section of the lead sheathing about the vicinity of the fracture, and closely examine the paper wrappings for a dark greenish deposit, which indicates the presence of copper. Should such be present, even to a traceable degree, the damaged section must be cut out without hesitation, otherwise the subsequent insulation resistance of the cable will never be satisfactory. Further, all the elements for short circuits will be present. Hence it is evident that the opportunity of preventing even one short-circuit, to say nothing of the fact that the cable will be restored to its original condition, will more than repay the additional cost, if any, in making good the damage.

Should a long length of main cable of loose construction be saturated with water no time should be lost in diverting the working circuits to another cable, after which the damaged cable should be examined and a decision arrived at as to the best course to be adopted in the circumstances.

Since preparing the foregoing notes an interesting case of the condition of a main cable which had been damaged by water came under the writer's notice. A few years ago water got into a cable at a joint in one of the City of London manholes, and the cable was dried out by heat and air and the working circuits handed over apparently duly restored. A few weeks ago it was found necessary to bring into use several of the spare wires in the cable when it was found that six pairs were short-circuited. After making Bridge tests it was decided to remove a certain lead sleeve, which happened to be the sleeve which was put on over the damaged section. The insulating paper of practically every wire was distinctly tarnished by copper while several of the outside pairs were quite useless. Needless to say the joint was re-made and the faults disappeared.

R. J. L.

NOTES AND COMMENTS.

ANGLO-BELGIAN TELEGRAPH COMMISSION, 1911.

THIS Commission was appointed to consider what improvements should be made in the utilisation of the existing submarine cables between the two countries.

The Commission met during the second week in November, and consisted of the following delegates:

M. Dussart, Ingénieur Principal; M. Piérart, Inspecteur; M. Bocquet, Ingénieur; Mr. A. J. Stubbs, Assistant Engineer-in-Chief; Mr. F. P. Didden, Assistant Controller, C.T.O.; Mr. A. C. Booth, Staff Engineer.

There are four separate submarine cables between the two countries, as shown in the following table:

Cable.	Type.	Length.	Date.
Dumpton Gap–Middlekerke; also known as Ramsgate–Ostende	6-wire telegraph	58·5 knots	1853
St. Margaret's Bay–La Panne I; also known as Dover–La Panne I	4-wire telegraph	47·8 "	1866
St. Margaret's Bay–La Panne II; also known as Dover–La Panne II	4-wire telephone	47·2 "	1902
St. Margaret's Bay–La Panne III; also known as Dover–La Panne III	4-wire telephone loaded	48 "	1911

All telegraph circuits are worked by the Hughes type-printing telegraph apparatus either on the simplex or duplex method as required by the necessity of the traffic. As the cables are comparatively short there are no repeaters in the circuits to the Belgian towns, but at Brussels repeaters are used on the circuits which are extended into Germany, and at London on the Antwerp circuit, which is extended to Liverpool.

The telegraph circuits are used as shown in the following table:

Conductor.	Communication between	Apparatus.
Ostende cable:—		
1	London–Cologne	Hughes simplex.
2	" Antwerp	" duplex.
3	" Ghent	" simplex.
4	" Brussels	" "
5	" Dusseldorf	" duplex.
6	" Frankfurt	" simplex.
La Panne I:—		
1	Liverpool–Antwerp	" "
2	London–Brussels	" duplex.
3	" Antwerp	" "
4	" " (Anglo Co.)	" simplex.
La Panne II:—		
2′ (superposed on a telephone loop)	London–Cologne	" "

From the above it will be seen that there is a total of eleven circuits giving fifteen channels of communication. In the busy hours of the day the accommodation is barely sufficient to carry the traffic as expeditiously as is necessary, and should any of the lines become interrupted or either cable be broken the service suffers considerably.

The Commission has recommended the use of the Baudot system as being the one most suitable for providing the desired improvement, and at the same time retaining the advantage of directly printed telegrams in Roman type.

It is anticipated that Baudot quadruple duplex will be possible, but as triple duplex (six channels per circuit) will give a sufficient increase in the number of available channels for immediate requirements, it has been suggested that such an installation should be provided for trial on the London–Antwerp service.

This practical test on this fairly difficult circuit, comprising a length of submarine cable, subject to inductive interference from the other circuits through the same cable, and connected to aërial lines at each end, which are subject to variations in insulation, etc., will prove a useful experience. It will also to some extent provide an answer to the question whether it is advisable to utilise the duplex balance on the Baudot system generally, or to use it as a simplex system only. In the latter case much greater accuracy in adjustments is necessary owing to the fact that the segments are about half the length on a simplex set as compared with a duplex set giving the same number of channels.

This practical test should be of great interest to the several continental administrations now making considerable use of the Baudot system, as it will indicate which is the easier to maintain:

(*a*) Accurate adjustments to small segments; or—

(*b*) A duplex balance to segments twice as long.

On underground lines where the electrical conditions are stable, the duplex balance has already justified its use on a quadruple set giving eight channels carrying from 400 to 600 messages per hour.

THE "AUTOMATIC" SITUATION.

Quite a considerable amount of interest has been aroused by the announcement that the Post Office has decided to instal automatic switching equipment at some of its new or reconstructed telephone exchanges. The daily press, ever on the look-out for interesting copy, has not despised the subject, and through its means even the man in the street has received an impression that something new in the telephonic development of this country may be looked for very soon. Telephone engineers know very well that this something is not really new at all. The automatic method is as old as the common battery manual system, but, as it represents a much more radical departure from previous practice, the troubles and sorrows of its youth have been correspondingly multiplied and protracted. Only within the past few years have telephone men generally awakened to the fact that the automatic exchange has arrived, that it will work, that the public like it and will work it, and that under proper conditions it will give more economical and better service than the manual system upon which most of us had previously been inclined to pin our faith. The British Post Office is no pioneer in this matter. With characteristic caution it enters the field at a comparatively late stage, when it is able to reap the advantage of the experience gained by more adventurous administrations in America, Germany, Austria, Holland, Sweden, and elsewhere. So far only three small orders have been placed by the Post Office, and these cover installations of, roughly, 500 lines each—at Epsom, Caterham, and the G.P.O. buildings in London. Plans for larger installations, up to 10,000 lines, are under consideration.

At Epsom the Strowger system with its well known finger-dial calling device is being installed. The apparatus has been delivered and its erection only awaits the completion of the switch-room. Caterham will have the Lorimer system, which employs telephones fitted with levers which enable a subscriber to set up the digits of the number required and check its correctness before he sends in the call. The relative merits of the finger-dial switch and of the setting levers as a calling device have never been authoritatively determined, and these two installations will help the Post Office to come to a conclusion on this point. Most automatic systems can be worked with either arrangement, but from the subscribers' standpoint the matter is one of some importance. The preference of engineers is naturally for the dial switch, which is much the simpler of the two devices and cheaper both to supply and to maintain.

The Lorimer is a power-driven system and includes a series of geared shafts and clutches, maintained in continuous rotation by a motor, and furnishing the necessary motion to the switching apparatus when required. The function of the relays and magnets associated with the selecting switches is thus one of control only.

The Strowger apparatus, on the other hand, is normally at rest, and all the motions of its switches are directly produced by the signalling and selecting impulses acting upon the electro-magnets of the switches. The determination of the relative merits of these two principles is still a matter in which the opinions of advocates of automatic systems are divided. It is interesting to note that among other leading systems now in the field, that of the Western Electric Co. includes a motor drive and a system of continuously rotating power shafts, while those of the American Automatic Co., the Kellogg Co., the North Electric Co. (Clement Auto-manual) and Messrs. Siemens and Halske (slightly modified Strowger) utilise direct electro-magnetic signalling impulses. Most of our readers will have noticed with interest the recent formation of an English company (the Automatic Telephone Manufacturing Co., Ltd.), which has acquired the extensive telephone works of the British Insulated & Helsby Cables, Ltd., at Liverpool, primarily with a view to the manufacture of automatic exchange equipment. The Western Electric Co. and Messrs. Siemens Bros. are also preparing for the manufacture of automatic plant in their London telephone works, and other large English firms of telephone suppliers are taking steps in the same direction. There thus seems to be every probability that it will be possible for the Post Office to maintain, in connection with automatic installations, the principle of competitive supply which is so dear to the hearts of Government Departments.

The automatic system still has its opponents, and among these one frequently finds a tendency to invoke the high authority of the engineers of the American Telephone and Telegraph Co. in support of the manual system against the automatic. This is both unfair and misleading. It is true that the American Telephone and Telegraph Co. has not at the present time any automatic or semi-automatic system in actual operation at a *public* exchange. The immense telephone interests which this company governs and the delicate conditions of its organisation introduce a host of considerations, from which the Post Office is free, and which make even the first step in the introduction of automatic switching a momentous one, which can only be taken after the very fullest deliberation and private experimental investigation. The company has, however, been so favourably impressed with the possibilities of automatic switching apparatus that it has spent a very large sum of money in experimenting with and developing a system of semi-automatic exchange working. Such a system requires the installation of apparatus identical in form and function with that of a full automatic system. The amount of automatic switching apparatus necessary at a semi-automatic exchange is, in fact, greater than at an exchange on the full automatic principle, since the counterpart of the subscribers' calling devices has also to be provided at the former.

The Chief Engineer of the American Telephone and Telegraph Company has publicly stated that he expects the introduction of the semi-automatic system to provide more efficient and more economical service that is given by the company's existing manual system.

For good or for evil, then we fear our engineers must face another long period of strenuous effort to master new problems and to adapt themselves to new conditions.

As regards lay-out of plant the automatic system is much less flexible than the manual, and the realisation of its best results depends more vitally upon the accuracy of the original installation plan. Guess and trial will not do. Surveys and traffic studies must be as full and complete as foresight can make them before the construction work involved in serving an area is begun. Junction problems and the costs of alternative methods of "satellite" exchange service can only be settled by looking far ahead. With the automatic system all parts of the area are to a great extent interdependent, and the area must be considered as a whole. Departures from the original plan cannot be introduced with the same facility and absence of waste as with the manual system.

The training of an adequate staff of exchange attendants is a subject of the greatest importance, and indeed one may safely say that it is here that the greatest difficulties of all are to be anticipated. The possibility of strikes and other labour troubles must be faced. Even at Chicago, the headquarters of the Strowger system, we hear that the new automatic installations are passing, or have passed through troubled waters from the labour standpoint.

One is confident that the staff of the Engineering Department will respond manfully to the extra calls which the introduction of the automatic system will make upon their time and their energy. The formulation of instructions and the dissemination of information on the subject will necessarily involve much careful and laborious work on the part of the Headquarters staff. In this work the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL will endeavour to bear its part, and in our next issue we hope to present our readers with an article on the subject by an officer who is closely associated with the Post Office installations now in progress.

The 'Post Office Circular' of December 12th contained the following announcement:

ENGINEERING DEPARTMENT.

The Postmaster-General has pleasure in announcing that the Lords Commissioners of the Treasury have sanctioned a revision of the Engineering Department of the Post Office.

The future classification and rates of pay will be as follows:

Superintending Engineers and Staff Engineers.
£520—£20—£700.
London Allowance, £50.

Assistant Superintending Engineers and Assistant Staff Engineers.
£420—£20—£500.
London Allowance, £40.

Executive Engineers.
£315—£15—£405.
London Allowance, £30.

Assistant Engineers.
£105—£15—£300.
London Allowance, £20.

Chief Inspectors.
£150—£10—£200.
London Allowance, £20.

Senior Inspectors.
London 57s.—2s.—65s.
Provinces 52s.—2s.—60s.

Inspectors.
London 30s.—1/6—55s.
Provinces 30s.—1/6—48s.

Skilled Workmen, Class I (Established).
London 39s.—1/6—47s.
Provinces 37s.—1/6—45s.

Skilled Workmen, Class II
(Established).
London 26s.—1/6—38s.
Provinces 24s.—1/6—36s.

Skilled Workmen (Unestablished).
London 6¼d. to 7¾d. per hour.
Provinces 5d. to 7d. per hour.

Unskilled Labourers (Unestablished).
London 6¼d. to 7d. per hour.
Provinces 5d. to 6d. per hour.

Boys and Youths.
London 2½d. to 4¼d. per hour.
Provinces 2d. to 3¾d. per hour.

The present distinction between the Maintenance and Construction Staff will no longer obtain; and the whole of the adult force below the rank of Inspector will be divided into skilled and unskilled classes.

Fifty per cent. of the skilled workmen will be established; and these will be divided into two classes, whose rates of pay will be those shown above. The whole of the established linemen and mechanics will fall into the two classes of established skilled workmen; and the application of the above-mentioned percentage will result in the creation of about 1100 new established posts, to be filled from the unestablished maintenance and construction ranks.

None of the new engineering classes will be entitled to stripes; but a right to continue to receive stripes will be admitted in the case of all individuals who have rendered any stripe-bearing service in the Post Office.

Service on the new class of Unskilled Labourer will not be taken into account for pension purposes, except in the case of persons who have rendered service in the old class of Labourer (Skilled and Unskilled), and who have therefore had reasonable ground for expecting that the whole of their adult unestablished service would be included for pension purposes when followed without break by established service.

The assignment of the existing staff to the various classes will be notified to the individuals concerned as soon as possible. The whole of the officers borne on one class will not necessarily find themselves upon one class after the revision.

In some minor respects, the conditions of service on the new classes will differ from those hitherto obtaining; and certain changes will also be made in the conditions governing recruitment and promotions. These changes will be announced as soon as possible.

In applying the new scale to the old classes of Assistant Superintending Engineers, Second Class Staff Engineers, and First Class Engineers, the immediate benefit to any individual officer to whom the new scale is granted will be limited to an increment not more than twice as large as the normal increment on the old scale.

THE REVISION.

The last general revision of the Engineering Department took place on August 17th, 1903. There is a tradition that a revision should be made every five years, but it does not seem to be in accord with facts, for it is on record that previous revisions took place on July 20th, 1897, August 7th, 1891, April 1st, 1889, and April 1st, 1881. It will be seen that the intervals beginning from '81 were eight years, two years, six years, and six years, and that the present revision has the doubtful honour of breaking the record for length of interval by four months. We are not taking into account a rearrangement of Engineers' salaries in November, 1904. It is not known how long the actual preparation of the revision has occupied, but apparently it has been spread over the last three or four years. For many months the revision, under its more familiar title of "the scheme," has been the main topic of conversation between engineer officers, and the near approach of the transfer of the National Co.'s staff has not tended to decrease the interest and anxiety with which its issue was looked forward to.

As we go to press shortly after the announcement has been made, sufficient time has not elapsed to allow of a safe judgment being formed as to the effect of the changes.

We may, however, trust ourselves to comment on two points:

Some officers who have received intimations that their present appointments are redundant, and that they will be held against positions on the Inspectors' classes, have concluded that they are now outside a door closed to further advancement. We do not know if their impression is right or wrong; but we hope that it is wrong, and that a way will be kept open for every man who acquires proper qualifications to make his way onward and upward. We are firm believers in the "marshal's baton" theory, and every student of human nature knows that men will work better and more happily when buoyed up by the possibility—no matter how slender—of ultimate advancement, than they will when they know that an arbitrary limit has been put to their progression. It is to be hoped that the announcement promised in the penultimate paragraph of the revision to the effect that "certain changes will also be made in the conditions governing recruitment and promotions" will allay anxiety on this head.

Much speculation is being indulged in as to the meaning of the last paragraph, the limitation laid down as to immediate benefit to officers *to whom the new scale is granted* having in some cases the effect of deferring the enjoyment of the scale to a dim and distant future. Probably, however, inquiries which are being made will elicit enlightenment on this matter.

The Transfer.

At midnight on December 31st, 1911, the thirty-one years' license of the National Telephone Company will run to its close, and a great and financially successful business organisation with its plant worth some number of millions sterling which we do not even dare to hint at and its 18,000 employees will pass into the ownership of the State.

Writing in mid-December and before the issue of the classification lists which our new colleagues may be excused for awaiting with great eagerness, we shall confine our remarks to the transfer as it effects our Journal.

Although the Staff of the Engineer-in-Chief will be suddenly inflated by a very large number of officers, we do not anticipate any immediate increase in our circulation, because we already include among our subscribers a large number of the Company's Staff. We do, however, anticipate, and hope for, and will welcome, an immediate increase in the number of our contributors. The Board of Editors of the Journal offers a hearty welcome to those who are now joining the staff of Post Office Engineers, and expresses the hope that the new life will not be less happy and prosperous than the old.

LOCAL CENTRE NOTES.

METROPOLITAN CENTRE.

President's Inaugural Address delivered at the Opening of the Session, October 16th, 1911, by Major W. A. J. O'Meara.

Gentlemen,—I do not desire to-night to disappoint you by claiming your attention to a lengthy address. You will have read—possibly with some satisfaction—that my remarks are to be brief. Personally, I think that there is much to be said on both sides in favour of a short address on this particular occasion. At the outset, I should like to say that the Metropolitan Centre is to be congratulated on the fact that the average attendance at the local meetings is well maintained. Moreover, the fact that we have such a full programme for the Session which opens to-night happily encourages the belief that the interest in the work of this Institution is by no means on the wane, and that we can still expect to reap many advantages from the readiness of our colleagues to place their experiences before us. Further, looming ahead is the transfer of the National Telephone Company business to Post Office control, and this fact suggests the possibility of a substantial increase in the membership of this Institution, probably before the end of the present session. While referring to this matter, I feel that I would like to extend on behalf of the Institution a very cordial welcome to those members of the engineering division of the Company's staff who desire to join the Institution in due course. It goes without saying that a no less cordial reception will be accorded to any offers which may be made by members of the transferred staff to read papers before the Institution.

As you know, considerable attention has been devoted recently by influential bodies and by the press and public generally to the matter of the education or training of engineers as well as to the subject of the value of degrees. The first-named subject is one which is very familiar to members of this Institution—having been dealt with specially on one or two occasions—and I have no doubt that most, if not all, of you have read with great interest that portion of the address delivered some weeks ago by Sir William Ramsay before the British Association which relates to this subject.

Possibly you may remember Sir William's apt remark: "In England we have made technical education a local, not an imperial question. Instead of half a dozen first-rate institutions of university rank, we have a hundred . . . and the training given is not that for captains of industry, but for workmen and foremen."

That the fallacious idea prevails, sad to say far too widely in this country, that the functions of an engineer correspond to those of a foreman, is, I think, beyond doubt, and it is in the interests of, and it should be the aim of, engineers to remove this wrong and sometimes mischievous impression. There are, it is true, "quack" engineers in this world, as there are "quack" doctors, but with this distinction: that while the medical profession has secured legal protection against "quackery," such protection has not, unfortunately, been secured by the engineering profession. I believe that a great amount of injury has been done, and is still being done, by "quack" engineers, and I consider that some system of registration should obtain, and that before a young man is admitted to practice as an engineer, he should be required to submit some suitable proof of his qualifications for the profession. This raises the question of the value to be placed upon the possession of scientific degrees. Those who have followed the discussion which took place at the Institution of Civil Engineers during the past summer on the important question of the training and education of engineers will not have failed to have discovered that there was a marked division of opinion on the subject of the value of degrees. Naturally, one has been anxious to discover the reason for this difference. It seems to me that what the commercial world is looking for is something in the nature of a hall-mark indicating the quality of the probable practical efficiency of the embryo engineers. The employer really desires that the student turned out from our educational establishments shall bear some mark which will not only indicate the amount of his theoretical and practical knowledge, but also his real power to apply this knowledge to the work which the young engineer may be called upon to undertake rather than a degree indicating examination room performances. The requirements for the degrees conferred under the present system are largely based on considerations more limited than those in the contemplation of the manufacturer or other employer, and it is not surprising, therefore, that so much disappointment is felt in commercial circles with the degrees which are being so liberally bestowed, and which, necessarily, are almost wholly granted in respect of academic attainments of a certain order. I recognise that the situation is a very difficult and far-reaching one. It may be that too many young men entering the engineering profession commence to specialise too early in life, to the neglect of their general education. Further, it may be that the fascination of science and the details of the application of its principles to particular engineering problems tend to absorb completely the attention of the majority of the students, to the exclusion of matters a knowledge of which is essential if the engineer is to be something more than a mere tool to do the bidding of those not having the same intimate knowledge of his craft. The solution of the difficulty can be effected if, for the present requirements for a degree, there can be substituted some means for marking down a man's qualifications in such a way as to include not only his theoretical knowledge, but also his ability to apply it readily and effectively in a mundane organisation, in which it must be recognised that human beings, and not the materials used, constitute the factor of prime importance. In condemning the system under which degrees are granted, it is necessary to guard against the danger of a wholesale condemnation not only of the system itself but also of all those on whom these degrees are conferred. Until the present system is modified, it seems to me that the degree must be accepted as an indication mainly of certain scholastic attainments, and that the employer must himself be content to undertake the task of assessing the value of the personal and practical qualities of each aspirant engineer. It is little wonder that such great interest has been aroused recently in the matter of the training and recruiting of engineers. The reason is not far to seek. Everyone who has any knowledge of the practical side of engineering fully recognises that owing to the advances which have been made in recent times and to the large sums of money involved in engineering schemes, it is more and more necessary that the proper class of young men should be drawn into the profession. I am persuaded no surer way to do this exists than that of properly appreciating the status and the value of the work of engineers. Sir James Inglis doubtless had this matter in mind when, some three years ago, in his Presidential Address before the Institution of Civil Engineers, he pointed out how important it was that the engineering work in Government Departments should be entrusted only to highly trained engineers. In view of Sir James's personal experiences not only as an engineer but as an administrator, his opinion in this connection is very valuable, and it is hoped that at no distant date his views on this subject will be very widely shared by all those in the highest authority.

In closing, I would remark that if a full recognition of the status of engineers is to be secured, not only must each individual engineer display adequate professional and general knowledge, but the whole body of engineers must also actively co-operate to obtain the creation of a governing body to effect an efficient control over their profession, and thus to protect adequately their own interests and those of the public generally.

The Committee have arranged for a most interesting and instructive series of papers to be read at the general meetings of the Centre during the winter session. This anticipation has been borne out by the successful meetings held on October 16th and November 13th.

On the first-named occasion the President delivered an inaugural address, a report of which appears above, and afterwards read a paper entitled "The Various Systems of Multiple Telegraphy," which had been prepared by special invitation for the International Congress held at Turin.

The subsequent discussion was opened by Mr. Moir, and was continued by Messrs. Stubbs, Slingo, J. E. Taylor, Pollock, Elliott, and Lack. The President replied.

Upon the motion of Mr. J. M. G. Trezise, who had occupied the Chair during the reading of the paper by the President, a hearty vote of thanks was tendered Major O'Meara.

At the meeting of November 13th Mr. W. S. Mountain read his paper on "Departmental Contracts."

The object of the paper was to explain the policy of the Department with regard to works given out to contract, and to explain the clauses of the agreement which the successful tenderer has to enter into with the Postmaster-General when given a contract by the Department. Mr. Mountain illustrated his remarks by quoting cases in which difficulties had arisen under the various clauses. The discussion, which was of a most interesting character, was opened by Mr. Noble, and was continued by Messrs. Gunton, Warren, Turner, Cornish, Myles Hook, Hines, and Bartholomew.

Mr. Mountain replied to the various points raised, and was accorded a hearty vote of thanks.

On November 2nd 60 members of the Centre paid a visit to the Royal Small Arms Factory at Enfield Lock.

They met with a very cordial reception from the officials, and under the guidance of the officers who had been deputed by the Superintendent to take charge of the party, spent a most interesting afternoon in inspecting the various processes by which small arms are made for the Army. The visitors were much struck by the effective yet simple methods by which the respective operations were carried out.

The Committee have made arrangements for visits to the National Physical Laboratory and the Associated Portland Cement Works respectively.

The visit to the Laboratory will, at the request of the Director, take place after Christmas, and the date of this visit, and also that to the Cement Works, which will also take place in the new year, will be announced in due course.

EASTERN CENTRE.

The Opening Meeting of the Session 1911–12, which was rendered notable by the attendance of the members of the Council of the Institution, was held at Cambridge on the afternoon of Tuesday, September 12th, 1911.

The Chairman, Mr. J. F. Lamb, in his opening remarks welcomed the Council to the meeting, and explained that Mr. A. W. Martin, who had promised to speak on the subject of "Costs Involved in Telephone Transmission," was unable to be present owing to official business, but that Mr. E. H. Shaughnessy had, at short notice, kindly consented to fill the breach.

Mr. Shaughnessy then delivered a very interesting lecture on "The New Scheme of Primary Centres for Telephoning the Kingdom," giving particulars of the special study which had been undertaken at Headquarters with the object of framing a scheme which should provide for the rapid development of the Trunk Telephone Service that might be expected in the near future. The proposals had in view the possibility of economically bringing within the limits of commercial efficiency conversation between any one subscriber and any other subscriber in the United Kingdom. It was shown that by using heavy-gauge conductors for main circuits between the selected primary centres corresponding reductions in the gauges of the wires between primary and zone centres and zone centres and trunk centres, etc., could in some cases be effected.

A very full discussion followed. This was opened by Mr. H. R. Kempe, and taken part in by Messrs. F. S. Parkinson, A. Evans, W. H. Calveley, J. F. Lamb, A. R. Nichols, T. Cobbe, H. G. Tissington, P. Dunsheath, and W. Slingo.

Mr. Kempe was of opinion that there was a possibility that the proposals might be considerably modified by the introduction of loading coils on open lines. Experiments were about to be made of loading two wires between London and Leeds. Mr. Kempe also gave the meeting some very valuable information with respect to the new loaded telephone cables leading to France and to Belgium.

Mr. Slingo, who said the Council were delighted to meet the members of the Local Centre, stated that the question of the best means of telephoning the country was one which had been exercising the minds of engineers for a long time. The opening of exchanges with limited service always led to trouble. It ought to be possible to join subscribers through without terminal losses. He expressed the opinion, which was much welcomed, that the insertion of testing points on telephone trunk lines should not be too liberal, and such maintenance of the lines as would prevent the occurrence of faults should be the aim of the engineer.

On the afternoon of Tuesday, November 7th, 1911, Mr. W. S. Mountain, of the Engineer-in-Chief's office, visited Cambridge and read his paper on "P. O. Engineering Department Contracts." The various clauses contained in the contract forms were examined, particular reference being made to Form E.-in-C. 137. Mr. Mountain's remarks on the main reasons why certain engineering work is done by contract were of special interest to those present.

The discussion was opened by Mr. W. Scarr and taken part in by Messrs. J. J. Dwyer, A. H. Dell, T. Cobbe, E. H. Shaughnessy, W. H. Calveley, and A. Gwilliam, and was valuable as indicating the various points of view from which the subject is treated mainly by the outside engineer and the inside accountant. It is thought that a good mutual understanding of the difficulties on both sides resulted and much profit will accrue from the meeting.

NORTH-EAST CENTRE.

The session opened on October 26th, 1911, when a most interesting paper entitled "Recent Developments in Telegraphy" was contributed by Mr. T. E. Herbert. The subject-matter was mainly concerned with the various systems of type-printing telegraphs now in use, and during the progress of the meeting a number of photographs of various types of apparatus were handed round for the information of those present.

At the close of the meeting Mr. Sinnott expressed the regret he felt at leaving the district, and, in referring to the transfer of the Sheffield and Bradford Sections to other districts, wished the members concerned the best of luck under the new conditions.

Mr. Longden, in a few well-chosen words, voiced the good wishes of the staff who remain attached to the North-East District for the future of those gentlemen about to be transferred.

On November 20th Mr. E. H. Farrand read an instructive and practical paper on "Mileage Records."

Mr. T. B. Johnson, the Acting Superintending Engineer, in his opening remarks, said it gave him great pleasure as a Yorkshireman to again take up duty in the county of broad acres, and he hoped he might spend many years amongst us.

In the course of his remarks Mr. Farrand showed how the mileage records of his Section had been placed on a more satisfactory basis by the introduction of specially designed card-indexes.

The animated discussion which followed went to show that the lecturer had selected a subject having a very real bearing on the work and interests of the members.

On behalf of the members Mr. Johnson bade farewell to Mr. F. Reid, who was under instructions to leave for Headquarters the following day.

On October 26th a smoking concert was held at the Hotel de Ville. Mr. J. Sinnott presided over a good company, and an excellent programme of recitals and musical items, arranged by Mr. H. N. Bard, was presented, to the enjoyment of all present.

During the interval the Chairman took the opportunity of wishing the staff good-bye ere his return to London to take up duty in the Engineer-in-Chief's office. He also referred to the pending transfer of the Bradford and Sheffield Sections to the North-Western and Midland Districts respectively, and wished all concerned every success under the new conditions. Messrs. Longden, Pickering, and Farrand, on behalf of the District Staff, also supported the expressions of goodwill made from the chair, and Mr. T. E. Herbert (Sheffield) and Mr. W. J. Finlayson (Bradford) responded.

NORTH-WESTERN CENTRE.

The first meeting of the 1911–12 session was held on October 2nd, when the Chairman of the Centre delivered his Inaugural Address. There was a good attendance of members, and the address covered a wide field and proved full of interest. A vote of thanks to Mr. Groves was passed unanimously.

On November 6th a meeting of the members of the North-Western District and new South Lancashire District was held to hear Mr. R. Nimmo deliver his paper on the "Manchester Fire Alarm System." The paper was illustrated by means of numerous slides, and the system was described in detail. A good discussion followed, and the meeting closed with a vote of thanks to the lecturer.

SOUTH WALES CENTRE.

Mr. W. S. Mountain occupied the attention of a meeting of the South Wales Centre of the Institution held at Cardiff on October 10th with his paper on "Departmental Contracts." The subject is, at this juncture, specially appropriate to the South Wales District, as a main underground route is planned, to extend from Berkeley Heath, on the east, to Worcester, on the north, and Haverfordwest, on the west. The Berkeley–Worcester section has been completed, but the West Wales route has only recently been commenced, and consequently many members who anticipate a further acquaintance with the underground contractor at an early date listened on this account with additional interest to the reading of the paper.

Mr. A. W. Sirett, who carried out the Berkeley–Gloucester–Worcester Section of the route mentioned above, made special reference to his experiences on this work in a paper on "Main Underground Work," which he read before the succeeding meeting held on November 14th.

Both of these papers proved very interesting, more members than usual participating in the discussions. Guided by Mr. Mountain's "hints" and Mr. Sirett's "experiences" the extension of the main underground westwards should have no terrors for the engineering officers who will in due course have to undertake the work.

'Wireless Telegraphy,' by Erskine Murray.—A new edition of this work has been added to the South Wales Reference Library.

SCOTLAND EAST CENTRE.

The 1911–12 Session was opened on October 25th, when Mr. Mountain, of the Headquarters Staff, read a most instructive paper on "Departmental Contracts" before a large attendance of members.

Mr. Machugh, Superintending Engineer, presided.

Mr. Mountain dealt with his subject in a very able manner and covered all the main difficulties met with in specifications and conditions of contracts.

On conclusion of the reading an interesting discussion followed and Mr. Mountain was thereafter accorded a very hearty vote of thanks.

On November 29th Mr. G. C. Jefferyes read a very interesting paper on "Block Signalling" before a good attendance of members. The lecturer dealt with the subject under the following headings:

(1) The early methods of controlling railway traffic; the time-interval system; passing places; defects of system.

(2) Introduction of electric block; the staff and ticket system.

(3) The electric tablet and staff systems; methods of controlling traffic with these.

(4) Webb and Thompson's block apparatus; mechanical and electrical details and their inter-relation.

(5) Blocks for double-line working; classification and general principles of design; early forms; single-needle instruments used as block apparatus.

(6) Instruments worked (*a*) by permanent currents; (*b*) by transitory currents; Preece's apparatus.

(7) Detailed description of Preece's single wire block; electrical action: method of working.

(8) The telephone as an adjunct to the block; joint use of line-wires for block and telephone connections.

On conclusion of the lecture Mr. Jefferyes was, on the motion of Mr. Machugh, who presided, heartily thanked for his excellent paper.

The lecture was illustrated by fourteen lantern-slides, shown by Mr. Tyson.

On the afternoon of Wednesday, December 20th, 1911, Mr. Gill will read a paper on "Records," and in the evening of that day a whist drive and dance will take place in the Carlton Hotel, Edinburgh.

SCOTLAND WEST CENTRE.

The first meeting of the Branch was held at the Technical College, George Street, on October 26th, Mr. Stewart, our Chairman, presiding over a good attendance.

The Chairman, referring to the great superiority of the room in which the meeting was held to the linemen's room used for previous meetings, proposed a hearty vote of thanks to the Governors of the College for the privilege they had afforded, and this was carried with acclamation. Mr. Mountain then read his paper on "Departmental Contracts," and the Chairman, Mr. Angwin, and Mr. Fossett took part in the discussion.

The second meeting of the session was held at the Technical College on Monday, November 20th, when a paper by Mr. A. S. Angwin on "Exchange Transfers" was read, enjoyed, and discussed.

On Friday, December 15th, our Annual Dinner is to be held at the Arcade Café. A good gathering is anticipated, and visitors are expected from the Scotland East District and from the National Telephone Company.

PROGRAMMES OF CENTRE MEETINGS.

SESSION 1911-12.

METROPOLITAN CENTRE.

1911.

October 16th.—Opening address followed by "The Various Systems of Multiple Telegraphy." The President.

November 13th.—"Departmental Contracts." W. S. Mountain.

December 11th.—"Distribution by means of Parallel Cables." E. A. Pink.

1912.

January 8th.—"Precautions against Fire." A. J. Stubbs.

February 12th.—"Economics of Telephone Transmission." A. W. Martin.

February 26th.—"Machine Switching in Telephony." B. O. Anson.

March 11th.—"Telegraph History." H. R. Kempe.

April 22nd.—Annual General Meeting.

The meetings are held in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C., at 6 p.m.

Proposed Visits to Works will be announced from time to time.

EASTERN CENTRE.

1911.

September 12th.—"New Scheme of Primary Centres for Telephoning the Kingdom." E. H. Shaughnessy.

November 7th.—"Departmental Contracts." W. S. Mountain.

1912.

January 9th.—"Staying a Telegraph Line." T. Cobbe.

February 6th.—"Faults." W. Scarr.

March 5th.—"The re-modelling of a Main Telegraph Line." H. A. McInnes.

April 2nd.—(Subject to be announced later.) F. W. Cheshire.

NORTH-MIDLAND CENTRE.

1911.

October 11th.—"Departmental Contracts." W. S. Mountain.

† "Wayleaves." J. E. Devey.

† "Wireless Telegraphy" (with experiments). H. M. Campbell.

† "The Slide Rule." N. F. Cave-Brown-Cave.

† Date not yet fixed.

INSTITUTION

NORTHERN CENTRE.

1911.

October 24th.—"Departmental Contracts." W. S. Mountain.

November 21st.—"Lifts and New Heating Plant at Newcastle H.P.O." H. R. J. Dunthorne.

December 19th.—"New Electric-Pneumatic Plant at Newcastle H.P.O." H. R. J. Dunthorne.

1912.

January 23rd.—Visit to Armstrong College, Newcastle.

NORTH-EASTERN CENTRE.

1911.

October 26th.—"Recent Developments in Telegraphy." T. E. Herbert.

November 27th.—"Mileage Records." E. H. Farrand.

† "Departmental Contracts." W. S. Mountain.

NORTH-WESTERN CENTRE.

1911.

October 2nd.—Inaugural Address. J. W. Groves.

November 6th.—"Manchester F.A. System." R. Nimmo.

December 4th.—"Departmental Contracts." W. S. Mountain.

1912.

January 8th.—"Telephone Transmission." W. Moon.

February 5th.—"Unit Costs" (Discussion).

March 4th.—"London County Council F.A. System." A. W. Field.

IRELAND CENTRE.

† "Departmental Contracts." W. S. Mountain.

NORTH WALES CENTRE.

1911.

October 23rd.—"Lineman's Duty Charts." R. G. Masaroon.

October 23rd.—Visit to Railway Signal Works, Fazakerley.

December 5th.—"Engineering Departmental Contracts." W. S. Mountain.

1912.

January 9th.—"Some Telephone Cord Circuits." T. Plummer.

February 5th.—"Wheatstone Working in Canada." J. Lockhart.

March 5th.—"Steel." B. J. Stevenson.

April 3rd.—(Subject to be announced later.) Annual Dinner.

Visits to Works will be announced later.

SOUTH WALES CENTRE.

1911.

October 10th.—"Departmental Contracts." W. S. Mountain.

November 14th.—"Main Underground Work," with special reference to the Berkeley Heath, Gloucester and Worcester Main Underground. A. W. Sirett.

December 12th.—"Wayleaves." E. D. Careless.

1912.

January 9th.—"Maintenance and Faults." J. Martin.

February 13th.—"Office Organisation and Equipment." P. E. Milford.

March 12th.—"Wireless Telegraphy," with special reference to P.O. Station, Fishguard. W. Pennington.

† Date not yet fixed.

SOUTH-WESTERN CENTRE.

1911.

October 12th.—Visit to Bristol Corporation Docks and Canadian Liner "Monmouth."

October 24th.—"Stores Distribution and Accounting." A. J. Ross.

November 12th.—"Departmental Contracts." W. S. Mountain.

November 28th.—"Theory of C.B. Telegraphs." R. Bradfield.

December 12th.—"Notes on Building Construction." G. W. Bannister.

1912.

February 12th.—"Re-modelling of the Irish Main Line, Rickmansworth to Broadway." H. A. McInnes.

March 12th.—"Bournemouth C.B. Exchange. Transfer from N.T. Co.'s Magneto Exchange." A. E. Chapman.

SCOTLAND (EAST) CENTRE.

1911.

October 25th.—Departmental Contracts." W. S. Mountain.

November 22nd.—"Block Signalling." G. C. Jeffreys.

December 20th.—(Subject to be announced later.)

1912.

January 24th.—"General Submarine Work." F. H. Machugh.

February 21st.—"General Submarine Work," continued. C. Crompton.

March 21st.—(Subject to be announced later.) J. McIntyre.

SCOTLAND (WEST) CENTRE.

1911.

October 26th.—Opening Address. D. Stewart.

October 26th.—"Departmental Contracts." W. S. Mountain.

November 27th.—"Exchange Transfers." A. S. Angwin, B.Sc.

December 18th.—"Some Notes on Estimating Work." T. Hetherington.

1912.

January 22nd.—"C.B. Installations." J. Richardson.

February 26th.—"Some Notes on Building Construction." W. Holmes.

March 25th.—(Subject to be announced later.)

ENGINEERING DEPARTMENT CHESS CLUB.

THE Chess Club opened its seventh season very successfully at "Ye Mecca," Cheapside, on October 3rd. The Championship and Handicap Tournaments are now in full swing, and much enthusiasm is being shown amongst the members. The membership has risen to over sixty, and weekly attendances are being very well maintained.

The League match with the Stores Department has been won, but a friendly match with the London, County, and Westminster Bank, and a League match with the London County Council have been lost. The match with the Paymaster-General's Office was also lost on adjudication.

CORRESPONDENCE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

INTERNATIONAL CONFERENCE OF TELEGRAPH AND TELEPHONE TRAFFIC ENGINEERS.

SIR,—The inauguration of International conferences and the congregating of specialists of different nationalities for the purpose of exchanging experiences, opinions and suggestions on matters of interest common to all has met with such support and encouragement from administrations concerned directly and indirectly that one may, perhaps, be excused if in searching for the most practicable solution of other problems, equally important, though in a different sphere, one suggests a conference not yet established.

It cannot be gainsaid that telegraph and telephone traffic officers, though I am inclined to place them under a more appropriate category, viz. engineers, have problems to solve unique in their peculiarity. I append a few.

(1) Distribution of traffic—inland and foreign.

(2) The effect of the telephones on telegraph traffic, and the potentialities of closer relationship of the two means of communication.

(3) Delivery of telegrams by telephone and the consequent reduction of boy labour.

(4) Automatic, semi-automatic and manual systems of telephony from commercial points of view.

(5) The calculation and provision of (*a*) equipment, including trunk and junction facilities, and (*b*) staff.

(6) Systems of operating, and operators' loads.

(7) Press and other exceptional rates.

(8) Registration of telephone calls and fees.

These subjects alone—and there are others no less important—afford sufficient material to compile a programme for International consideration and discussion, and the country which has the courage to take the initiative and convene a conference of telegraph and telephone traffic engineers will receive unquestionably no less hearty support than that accorded other institutions, and if but a few of the problems referred to above are solved the utility and efficiency of the dual service will be enhanced.

I am, Sir,
Yours faithfully,
GEO. W. J. PRAAT.

London Telephone Service,
October 28th, 1911.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

ENAMELLED COPPER WIRE.

DEAR SIR,—With reference to Mr. Smith's interesting paper appearing in this month's issue, can he please say if any alteration takes place in the gauge and resistance of the finer-sized wires passing through this process?

The wire is of course first drawn to standard gauge and resistance by manufacturers, and supplied bare for enamelling. This necessitates its being subjected to a certain strain when passing through the enamelling process and twice heated to a temperature of 600° F. Can Mr. Smith please say if any lengths have been specially tested to ascertain if any alteration takes place between commencement and final process of re-winding for sale?

INTERESTED.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—In reply to "Interested," standard sizes of bare wire are supplied by manufacturers. During the enamelling process the wire is not subjected to sufficient strain to affect its gauge. The resistance of a wire varies inversely as the square of its diameter; consequently, if the wire were stretched, an appreciable increase in the resistance would result.

Numerous conductivity tests show that there is no alteration in the resistance of the wire, even in the smallest gauges, after it has passed through the process.

Yours faithfully,
W. B. SMITH.

ELECTRICAL ENGINEERS AND THE PUBLIC.

WE reproduce hereunder some notable paragraphs from the Presidential address (American Institute of Electrical Engineers) of Dr. Dugald C. Jackson. Our readers are, we think, aware that the services of this able American engineer have been retained by the Department in connection with the valuation of the National Telephone Company's plant.

Dr. Jackson said:

> Members of the American Institute of Electrical Engineers are pleased to refer to electrical engineering as a profession, and to the Institute itself as a professional society. When this occurs as a thoughtless repetition of fine sounding words it has little meaning, since mere repetition of an alleged truth does not make it a real truth, and it can be established as a real truth only by tracing it to some adequate foundation. But when those statements arise from a ripe understanding that the word "profession" means more than a mere organised vocation for earning one's bread, it has a high and commendable meaning. The word "profession" "implies professed attainments in special knowledge, as distinguished from mere skill; a practical dealing with affairs, as distinguished from mere study or investigation; and an application of such knowledge to uses for others, as a vocation, as distinguished from its pursuit for one's own purposes." This sets the professional man in a position which demands from him an attitude of service and of leadership. He must have a masterly knowledge, in addition to skill in a vocation. He must deal practically in the affairs or needs of men. His duties must be performed with a touch of disinterested spirit in addition to the vocational spirit of earning his livelihood. Such men have a duty to the public; and in the performance of that duty, they must exert their influence on that thought and practice of the day which affects the

welfare and progress of the nation. We as electrical engineers cannot escape that duty in case we wish to maintain the professional character of our occupation.

. . . .

It may be retorted that the tenets which I am advocating will lead engineers out of a professional spirit and into "commercialism." It is worth while to pause here to reflect on that point. The word "commercialism" strictly means the characteristics of business or commercial life, but custom has made it applicable to any undue predominance of commercial ideas in a nation or community, and it has thereby come to infer a willingness to establish the strife for money in a position of precedence over reason and righteousness.

It has been alleged that learning loses of its dignity by becoming fashionable. It has also been alleged that learning loses of its dignity by becoming useful. Of the latter, at least, experience has proved the contrary—happily for engineers who are proud of their profession, for engineering is necessarily an embodiment of the useful application of knowledge and learning. Engineering, relating, as it does, to the application of the powers of nature to useful purposes, must necessarily bring its followers into intimate contact with commercial affairs in an age when, as in ours, the industries dominate commerce, and the abatement of war has reduced the importance of military engineering. The tenets which I advocate do not tend to entangle the engineers in the depths of "commercialism" with which they may come in contact; but, on the contrary, those tenets propose that engineers should safeguard and nourish their professional spirit by assuming a part in public affairs in a spirit of disinterest, for the purpose of guiding the useful applications of natural forces to the greatest practicable service to society. A true engineer is a devoted follower after truth. He differs diametrically from the devotees of pure "commercialism," who are strictly opportunists. He also differs from pure idealists, who are often notable for refusing to accept any advance unless it wholly meets their personal ideals. The spirit of the engineer rejoices in obtaining any move toward the truth, but is always seeking farther advance. This characteristic spirit has been manifested in men of great achievement in many walks of life. It is a part of the life of such men as Martin Luther, Gladstone and Lincoln.

. . . .

I have observed in Macaulay's writings a paragraph which is graphic in illustration of our present situation. "Everywhere," he says, "there is a class of men who cling with fondness to whatever is ancient, and who, even when convinced by overpowering reasons that innovation would be beneficial, consent to it with many misgivings and forebodings. We find also everywhere another class of men, sanguine in hope, bold in speculation, always pressing forward, quick to discern the imperfections of whatever exists, disposed to think lightly of the risks and inconveniences which attend improvements, and disposed to give every change credit for being an improvement. In the sentiments of both classes there is something to approve. But of both, the best specimens will be found not far from the common frontier. The extreme section of one class consists of bigoted dotards; the extreme section of the other class consists of shallow and reckless empirics."

The public, misled or annoyed by the reluctance of some honest but overcautious managements to make frank public statements of financial results and present convincing statistics of operation, enraged by the acts of a few adventurers who from time to time have secured a speculative hold in the public service field, and enticed by the arguments of individuals with ulterior motives, are likely to follow the radical leadership of demagogues or of honest but false empirics. This is a danger which seriously exists in states where no public supervision of the service companies is provided, and also in a lesser degree in states where such supervision has been established. The danger must be rolled back by the exertions of fair-minded and right-thinking men. A serious menace to the welfare of the nation would be caused if unfair dealing toward the public service companies were established as a policy. A scrupulously frank and honest dealing with the public by the companies should be insisted on, but the public must be taught the importance of dealing on its part with an equally scrupulous fairness and a well-balanced generosity. It is here that I say lies a duty of electrical engineers to the public. It is to give of their time and brain to convincingly establish the facts (the *facts,* I repeat) which the public do not understand in regard to the business of the public service companies, to indicate the means for rightly treating these new influences which we and our fellow engineers have been creating by our works, and to aid in establishing measures which will favour and sustain mutual confidence and fair dealing between them and the public. This is an obscure and difficult problem on account of its touching the edge of men's ambitions and men's passions, and it seems at times to possess the opacity and insolubility of a millstone; but looking persistently and with care into what appears to be a millstone not infrequently proves it to be composed of reasonably transparent material. The members of our Institute should take somewhat to themselves as professional men this obscure and difficult problem, and aid in its solution as a matter of their duty to the public.

IN INDIA.

Mr. A. E. McCloskey, expert in telegraph, telephone, and railway signalling systems, who comes from the Engineering Department of the British Post Office, and has been on loan to the Bombay, Baroda, and Central India Railway during the past eighteen months, has now handed in his report on the re-organisation of the Company's Telegraphs. It is understood that he has been successful in obtaining for the Company several concessions from the Government.—*Indian Engineering.*

THE MARCONIGRAPH.

THE November issue of the 'Maconigraph' contains some interesting articles showing the characteristic enterprise of Marconi's Wireless Telegraph Co., Ltd., in different parts of the world. The decision of the Russian Government some time back not to enter into contracts with firms other than those established in the country led to a decline in the business done by the Company with the Russian Goverment. A company was then formed, and to this fell a considerable portion of the contracts placed by the Russian Government. The Marconi Company have now secured the controlling interest in this company and their fine works, and the arrangement will enable the Marconi Company to take advantage of the very big business both present and future of the Russian Government, besides eliminating much of the competition which it would have to encounter otherwise.

The trials and tribulations of an engineer who went out to Siam to make trials with portable wireless apparatus is one more of the many interesting articles which will be found in the 'Marconigraph.'

The unsuccessful attempt of Mr. Wellman to cross the Atlantic in an airship is still fresh in the memory of our readers. Another attempt is to be made to accomplish the feat with the airship "Akron." According to the 'Marconigraph' the new airship will be 258 ft. long; it will contain 400,000 cubic feet of hydrogen, and will have a lifting capacity of 13 tons. The engine will be able to develop 317 horse-power, and the vessel will carry a 3-kilowatt Marconi wireless set of special construction. Mr. Jack Irwin, the wireless operator who accompanied the Wellman airship and who will be on the "Akron," contributes to the 'Marconigraph' some of his experiences, and demonstrates the important part played by wireless in the rescue of the daring aviators aboard the ill-fated Wellman airship.

LIBRARY NOTES.

THE following books have been added to the Institution Library, and are available for the use of members:

No.
191. 'Vector Analysis.' J. G. Coffin.
192. 'Propagation of Electric Currents.' J. E. Fleming.
193. 'Problems in Electricity.' R. Weber.
194. 'Structural Engineering.' J. Husband and W. Harby.
195. 'First Principles of Railway Signalling.' C. B. Byles.

New Editions.

677. 'Building Construction.' Mitchell.
23. 'Wireless Telegraphy.' J. E. Murray.
17. 'Electric Wave Telegraphy and Telephony.' J. Fleming.
751. 'Journal of the Manchester Municipal School of Technology,' vols. iii and iv.

NEW BOOKS.

'Dynamo and Motor Attendants and their Machines,' by F. Broadbent, M.I.E.E. (S. Rentell & Co., Ltd., 36, Maiden Lane, W.C. Price 1*s*. 6*d*.)

'The Telegraphists Guide,' by J. Bell and S. Wilson. (S. Rentell & Co., Ltd., 36, Maiden Lane, W.C. Price 2*s*. net.)

Another edition—the seventh—of this guide has just appeared, and we are pleased to note its continuous improvement. Its authors are apparently determined to leave nothing undone which will assist in bringing it to the front as a text-book for telegraph students.

New matter has been added on accumulators, concentrator switches, relays, duplex and quadruplex working, submarine cable working and the megger.

The student, even if well stocked with other text-books, would be wise to possess a copy of the Guide.

NEW LISTS.

Messrs. Wm. Geipel & Co. have issued a leaflet describing their time switches.

The "Arbiter" type is arranged for switching "on" by hand and for switching "off" automatically. It is particularly suited for use where the restricted hour system is adopted.

The "Opus" type is arranged to switch "on" as well as "off" automatically, and is suited for such purposes as the lighting of streets and large buildings, sign lighting, stair and corridor lighting. It can be arranged for various functions.

These switches have had a thorough trial during the last two years, and amongst others the Manchester Corporation have quite a number in use, and notwithstanding protection and keen competition on the part of local firms, Messrs. Geipel have secured a contract for sixty-eight Geipel steam traps for the New Copenhagen Hospital.

The India Rubber and Gutta-Percha and Telegraph Works Co., Ltd., Silvertown, E., have issued a new list, No. 40A, of their twin cables, flexible conductors and cords.

RETIREMENT OF MR. W. BROWN.

THE approaching close of the present year will constitute the end of another critical phase of the Post Office history of the telephone, and provide the final stepping-stone to absolute State domination of the telephone service in this country.

Several important features in that history have already been relegated to the past, and should it ever be the desire or duty of an industrial historian to record the various successes and failures of the earlier periods, it would be difficult to accurately delineate progress without a recognition of the influence of Mr. W. Brown, who has recently, after an exceptionally long career, retired from the Post Office service. His connection with the technical side has been so intimate that it is scarcely practicable to refer to any stage of Post Office development without associating his ability and work in a very direct and definite form.

As a pre-transfer servant of the United Kingdom Telegraph Company, he passed with the telegraphs to the control of the Postmaster-General, and was for many years the immediate subordinate colleague of Mr. M. Cooper, whose lamented demise, at a comparatively early age, left Mr. Brown to assume the responsibility of the engineering branch of telephone work under Sir John Gavey. This advancement occurred at a time when telephone matters were rapidly becoming an important factor in electrical communication. Trunk line working was then of a very limited character, and international telephones were non-existent. In connection with the latter, Mr. Brown took a prominent part in the establishment of a telephone service with Paris, and after the completion of this—at that time a colossal and distinctly novel work—he was closely identified with

William Brown.

the inauguration and construction of the backbone Post Office trunk system throughout Great Britain.

The introduction of large gauge copper wire and a number of telephone circuits on one route gave rise to one of many technical problems which fell to his duty to solve. This was rapidly followed by the inherent difficulties in speaking over multiple cables, and another set of adverse electrical phenomena had to be eliminated.

A climax, however, arrived with the acquisition of the trunk lines of the National Telephone Company in 1896, and Mr. Brown's energies and resources were taxed to the uttermost. It may safely be recorded that since then there has not been the slightest cessation of the continual demands upon his wide experience, capabilities, and persevering disposition.

This phase was rapidly succeeded by an equally exacting step arising out of the decision that the Post Office should seriously enter into competition with the National Telephone Company as far as regards local service. In accordance with the new policy thus initiated, it became necessary to establish a number of local exchanges of unusual magnitude in several London areas.

The central battery system, which had only recently matured as far as regards its application in this country, became the special charge of Mr. Brown. He has since occupied the onerous position of having to pursue in a very vigorous manner the inception and establishment of numerous important telephone schemes with all the accompanying ramifications entailed by modern requirements.

Although all this is now past, it was within the period of his service that unique difficulties arose in reference to the future carrying on of the whole of the telephone service by the State, and he has emerged from a very harassing period during which heavy demands were showered upon him.

It is, however, a misfortune that he is unable to take part in the culmination of his earlier labours, and although the monument is not completed, it must be a source of great satisfaction to him that the plinth and foundation have been to a large extent moulded by his hands.

The accomplishment of such laborious duties under extremely exacting conditions could not have been secured without the possession of some of those excellent characteristics which have made Mr. Brown an important unit in the telephone world. His work has been of that thorough description which is lasting, and when that is said nothing need be added.

It is not a matter of surprise or regret that after a strenuous life of many years, nature steps in and determines the limit of human energy. When it does no servant of the nation can lay down his pen with the knowledge of having successfully fulfilled his duty better than Mr. Brown.

F. T.

It is very good of the Board of Editors to give me an opportunity to add a note to the foregoing "Appreciation," but I fear that anything I can write must be in the nature of bathos when following Mr. Tandy's balanced and enthusiastic article. It is, however, an honour to be permitted to do honour to my old friend, so well known among old-stagers by Mr. Cooper's favourite title of "William Brown of Newcastle"! His strenuous labours and indomitable perseverance earned and well merited the steady promotion that came to him—labours persisted in often under grave disability in respect of health. To have been closely associated with the long list of important works to which Mr. Tandy refers marks a man of ability, and one's recognition and admiration are increased when one realises that the position was won by sheer merit, with no adventitious aid of either "influence" or "luck." Now, we very heartily wish him good luck and long life.

A. J. S.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

Promotions.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Alexander, R.	Engr., 1st Class	S.C.&T. Edin., '85; Jr. Clk., Eng'g. Dept., '98; Engr., 2nd Cl., '03.
„	Shaw, J. H.	„	S.C.&T. Belfast, '92; Jr. Clk., Eng'g. Dept., '98; Sub-Engr., '99; Engr., 2nd Cl., '03.
„	Baxter, J.	„	S.C.&T. B'ham, '87; Jr. Clk., Eng'g. Dept., '98; Engr., 2nd Cl., '03.
„	Hart, W. L.	Clk., 1st Cl.	S.C.&T. Cambridge, '95; Jr. Clk., Eng'g. Dept., '98; Clk., 2nd Cl., '04.
„	Storey, S.	Clk., 2nd Class	S.C.&T. Dublin, '89; Jr. Clk., Eng'g. Dept., '99.
„	Hardcastle, J. R.	„	S.C.&T. Leeds, '91; Jr. Clk., Eng'g. Dept., '98.

STAFF CHANGES.

RETIREMENTS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Murray, W. F.	Staff Engr., 2nd Cl.	Tel., '70; Relay Clk., '89; 2nd Cl. Engr., '94; 1st Cl., '00.
,,	McNab, R.	First Eng., "Monarch"	Ch. Engr., Unest'd., '83.
,,	Pollock, W.	Clk., 2nd Cl.	S.C.&T. Belfast, '82; Jr. Clk., Eng'g. Dept., '85.

TRANSFERS.

Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Kennedy, D. H.	Staff Engr., 2nd Cl.	E. in C.O.	Asst. Sup'g. Engr.	Met. C.	15 : 11 : 11
Batchelor, W. M.	Ditto	,,	Ditto	N.	23 : 11 : 11
Reid, F.	—	N.E.	Asst. Engr.	E. in C.O.	21 : 11 : 11
Hines, J. G.	—	Test Branch	,,	Met. C.	1 : 12 : 11
Hines, J. G.	—	,,	,,	Testing B'ch.	1 : 10 : 11
Buchanan, J.	—	Sc.E.	,,	N.W.	18 : 12 : 11
Osborn, W. M.	—	E. in C.O.	Second Class Engr.	Testing B'ch.	1 : 10 : 11
Tabor, H. J. H.	—	,,	Ditto	,,	1 : 10 : 11
Lawson, R.	—	,,	Probationary Sub-Engr.	Met. C.	19 : 10 : 11
Gleed, S. W.	—	,,	Ditto	,,	19 : 10 : 11
Jones, L. J.	—	,,	,,	,,	19 : 10 : 11
Jacquest, A. H.	—	,,	,,	Met. S.	19 : 10 : 11
McKickan, J. J.	—	,,	,,	,,	19 : 10 : 11
Banks, A. E.	—	,,	,,	,,	19 : 10 : 11
Macrae, D. L.	—	Met. C.	3rd Class Clk.	,,	31 : 5 : 11
Keane, M. J.	—	N. Wa.	,,	Ire.	3 : 4 : 11
Eginton, A. F.	—	E.L.	,,	Met. S.	16 : 10 : 11
Owen, W. G.	—	Met. S.	,,	E.L.	16 : 10 : 11
Gamgee, A.	—	Met. C.	,,	Met. S.	1 : 11 : 11
Delaney, W. J.	—	Met. S.	,,	Met. C.	1 : 11 : 11

COMMUNICATIONS.

All Remittances and Agents' Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

Editorial Communications and Correspondence should be addressed to Mr. D. H. KENNEDY, Norbiggin, 26, Oakley Avenue, Ealing, W. (Telephone, 1000 Ealing.)

SIEMENS BROTHERS & CO.,

LIMITED.

General Offices: WOOLWICH, KENT.

Works: WOOLWICH, and DALSTON, N.E.

Manufacturers of all Classes of

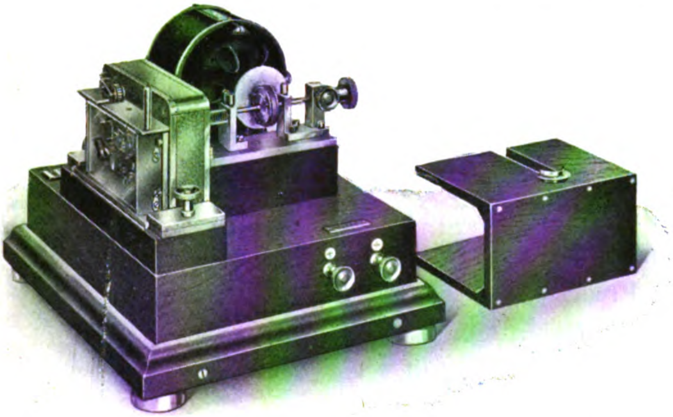
Telegraph Apparatus.

Obach, Hellesen, and Dura Dry Cells, and Fluid Batteries of all Descriptions.

The Patent Multiple Twin Telephone Cable and other Dry Core Telephone Cables.

India-rubber, Gutta-Percha, and Paper Insulated Cables and Wires.

Iron Telegraph Poles. **Insulators.**



Wheatstone Transmitter (Vyle's System)

—— Post Office Pattern ——

Driven by Siemens G.M. Motor.

NOTE. The electrical transmission portion of this instrument can be interchanged without removing any wires or disconnecting the circuit for more than fifteen seconds.

INDEX TO ADVERTISERS.

	PAGE
Alabaster, H., Gatehouse & Co.	iv and xii
Babcock & Wilcox, Ltd.	xvii
Britannia Rubber and Kamptulicon Co., Ltd.	ix
British Insulated and Helsby Cables, Ltd.	iii
British L.M. Ericsson Manufacturing Co., Ltd.	v
Concordia Electric Wire Co., Ltd.	ix
Crystalate Mfg. Co., Ltd.	xi
Dennis, W. F., & Co.	ii
Electrical Power Storage Co., Ltd.	xxii
'Electrical Review'	xiv
Endolithic Manfg. Co., Ltd.	xxi
Hart Accumulator Co., Ltd.	vi
India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.	xxiii
Johnson & Phillips, Ltd.	xxiv
Lamson Pneumatic Tube Co. Ld., and Lamson Store Service Co. Ld.	xv
London Electric Wire Co., Ltd.	ii
'Marconigraph'	x
'National Telephone Journal'	viii
Peel-Conner Telephone Works, Ltd.	xiii
'Saint Martin's-le-Grand'	xvi
Siemens Bros. & Co., Ltd.	xix
Smith, Frederick, & Co.	xxii
Traun, Dr. Heinr. & Sons	xv
Western Electric Co., Ltd.	xviii
Willcox, W. H. & Co., Ltd.	vii
'Zodiac'	x

Telegraphic Address:
"DENDRON, LONDON."

Telephone Nos.:
3421 London Wall (2 lines).
11630 Central.

THE ENDOLITHIC MANFG. CO., LTD.

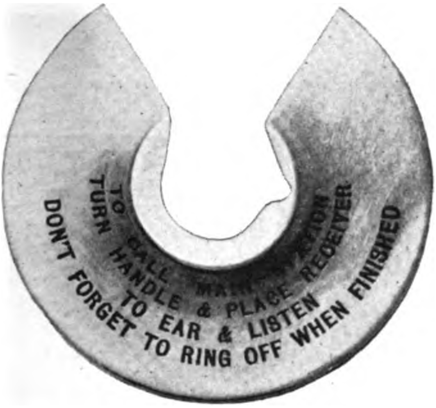
Pomona Buildings, Fore St.,
LONDON, ENGLAND,

— MANUFACTURERS OF EVERY DESCRIPTION OF —

Instruction Plates, Labels, &c.,

In Ivory, Ivorine, Bone, & all Metals.

CONTRACTORS TO GENERAL POST OFFICE,
NATIONAL TELEPHONE CO., Ltd., &c., &c.


TO CALL MAIN STATION
TURN HANDLE & PLACE RECEIVER TO EAR & LISTEN
DON'T FORGET TO RING OFF WHEN FINISHED

IN CASE OF FIRE CALL
NO. 13

Ivory Pegs for Telegraph Instruments.

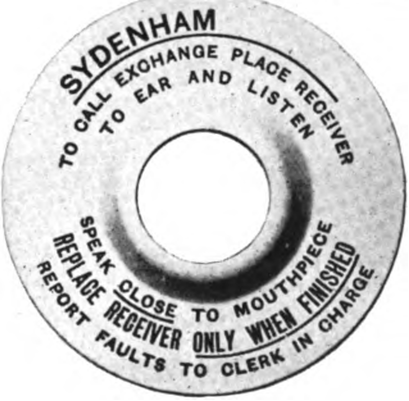
52

7

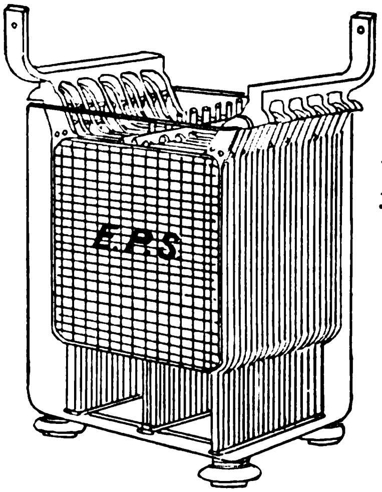
LONDON
982
WALL

The National Telephone Co. Ltd.
HEAD OFFICE,
TELEPHONE HOUSE,
VICTORIA EMBANKMENT,
LONDON, E.C.

AVENUE
90


SYDENHAM
TO CALL EXCHANGE PLACE RECEIVER TO EAR AND LISTEN
SPEAK CLOSE TO MOUTHPIECE
REPLACE RECEIVER ONLY WHEN FINISHED
REPORT FAULTS TO CLERK IN CHARGE

E.P.S. Accumulators



ACCUMULATORS
FOR
All Purposes.

DRY BATTERIES
FOR
Telephones, &c.

ELECTRICAL POWER STORAGE CO., LTD.
4, GREAT WINCHESTER ST., LONDON, E.C.
Telegrams: "STORAGE, LONDON." 'Phone: 1253 LONDON WALL.

FREDERICK SMITH & CO.,
Incorporated in
The London Electric Wire Co. & Smiths, Ltd.,
ANACONOA WORKS, SALFORD, MANCHESTER.

HARD DRAWN H.C. COPPER LINE WIRE.
Special Tinned H.C. Copper Wire.
COPPER TAPES AND BINDERS FOR LINE WIRE.
COPPER TROLLEY WIRE
SPECIAL NON-FOULING SECTIONS.
SILICIUM BRONZE WIRE
"C" Quality for Telephone Lines, &c.
ALUMINIUM WIRE & STRIP FOR ALL ELECTRICAL PURPOSES.

Silvertown

Cables:

Electric Light,
Telegraph,
Telephone,
Submarine.

Wires:

Insulated
India-Rubber or
Gutta-Percha, Cotton
and Silk Covered.

Dynamos:

Compound Wound,
Shunt or Series for
Electric Light and
Power.

Motors:

Belt or Direct
Drive, for all classes
of service.

Instruments:

For Telegraph and
Testing Purposes.

Batteries:

All classes of Leclanché,
Daniell's, Bunsen, &c.

Insulators

of every description,
Porcelain, Ebonite, &c.

THE INDIA-RUBBER, GUTTA-PERCHA and TELEGRAPH WORKS CO., LTD.

HEAD OFFICES—106, Cannon Street, London, E.C.

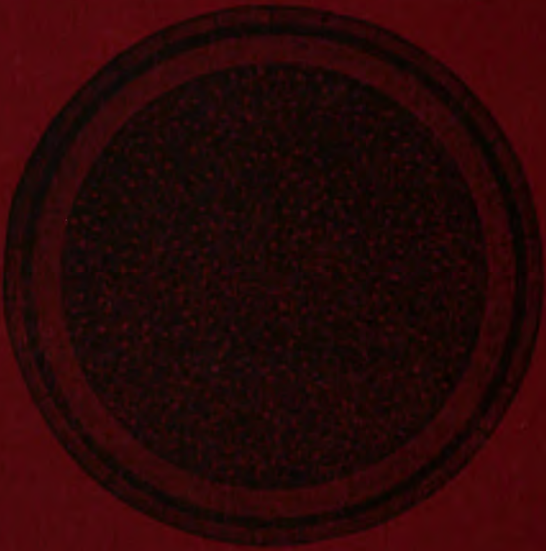
WORKS—Silvertown, London, E.

Telegrams—HEAD OFFICES: "Silvergray, London." WORKS: "Graysilver, London."

Branches:

Belfast: 75, Ann Street.
Birmingham: 15, Martineau Street.
Bradford: 1, Tanfield Buildings, Hustlergate.
Bristol: 22, Victoria Street.
Cardiff: Pierhead Chambers, Bute Docks.
Dublin: 15, St. Andrew Street.
Glasgow: 2, Royal Exchange Square.
Liverpool: 54, Castle Street.
Manchester: 16, John Dalton Street.
Newcastle-on-Tyne: 59, Westgate Road.
Portsmouth: 49, High Street.
Sheffield: 48, Angel Street.

JOHNSON AND PHILLIPS LTD
VICTORIA WORKS
CHARLTON. S.O. KENT
ESTABLISHED 1875.



TELEPHONE CABLES
WITH
EXTRA LOW CAPACITY.

THE
"METROFLAM"
ARC LAMP.

This Lamp has the
Lowest Running Costs
of any Flame Lamp.

Burns **80** hours at one trim.
Perfectly Steady.
Brilliant Light.

Printed and Published by H. Alabaster, [illegible] London.